GLEANINGS

FROM THE

FIELDS OF NATURE

By

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WITH AN INTRODUCTION BY

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'Ut ager quamvis fertilis sine cultura fructuosus non potest, sic sine doctrina animus.'—CICERO.

ILLUSTRATED WITH NUMEROUS PHOTOGRAPHS, PHOTO-MICROGRAPHS, AND DRAWINGS BY THE AUTHOR

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‘*Rerum Natura sacra sua non simul tradit.*’

SENECA.

NATURE UNADORNED.

PREFACE

MOST of the chapters in this little book were written in the quietness of a summer-house, and in the shade of trees during a very hot summer.

The studies are from copious notes, mental and written, made during very many enjoyable rambles along the shore, and through woods and by-paths of rural districts around Hastings and St. Leonards-on-Sea; and from careful examination of the objects under the microscope.

Very many persons greatly interested in Natural History are prevented by various reasons from the pursuit of the study; or of making research amongst the wonderful objects to be gleaned from the fields of Nature.

It is therefore a highly prized privilege to be permitted to offer these few studies for

the perusal of such persons, in the hope that they will in some measure compensate the reader for inability of personal research.

An effort has been made to avoid difficult and obscure technicalities, but, where unavoidable, scientifically correct terms have been employed rather than commonplace generalities.

All the illustrations (except where notified) are my own production, and the specimens they represent are in my private museum. I hope the illustrations will assist the reader to an enjoyable comprehension of the text.

My heartiest thanks are offered to my friend Dr. Anderson-Berry, for his excellent Introduction.

EDWARD CONNOLD.

1, St. Peter's Road,
St. Leonards-on-Sea.
April, 1908.

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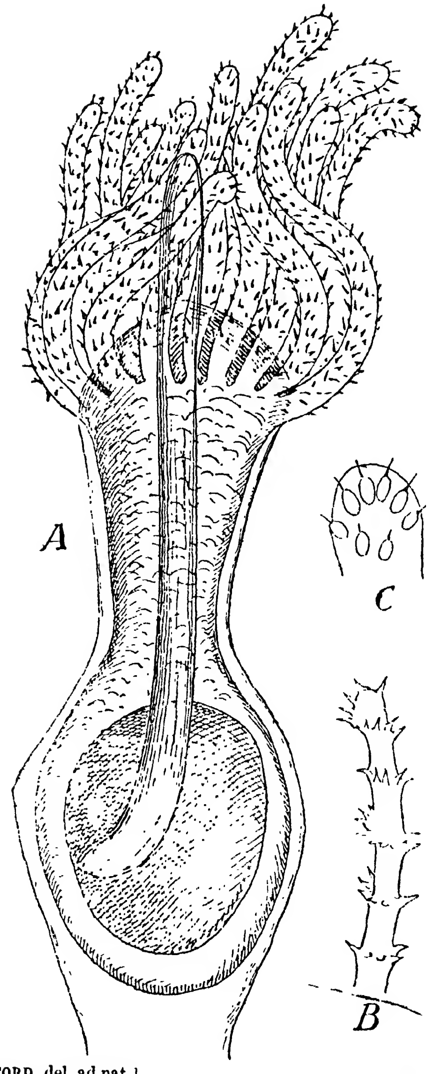


P. J. RUFFORD, del. ad nat.] [Much magnified.

A. Polypite of *Plumularia pinnata*, Linn., expanded and gorging a worm. *B*. Portion of a tentacle.
C. Eight dart cells (nematophores), *in situ*.

From *BRITISH HYDROID ZOOPHYTES*.

INTRODUCTION

By DAVID ANDERSON-BERRY, M.D., LL.D., F.R.S.E., F.R.S.L.

'Nature, the vicar of the almightie Lord.'
CHAUCER.

'The course of Nature is the art of God.'
YOUNG.

'In Nature's infinite book of secrecy
A little I can read.' SHAKESPEARE.

'Man is one world, and hath another to attend him.'
HERBERT.

'To him who in the love of Nature holds
Communion with her visible forms, she speaks
A various language.' BRYANT.

'Man stands as in the centre of Nature; his fraction of Time encircled by Eternity, his handbreadth of Space encircled by Infinitude.'—CARLYLE.

'Nature, with its melancholy charm, resembles a Bride who, at the very moment when she was fully attired for marriage, saw the Bridegroom die. She still stands with her fresh crown and in her bridal dress, but her eyes are full of tears.'—SCHELLING.

'MAN is the measure of all things!' quoth the old philosopher. And he was right; for, after all, what is the world around us but what we, with our five senses and our mind behind them, make it?

As every school-boy knows, the beautiful colours and myriad tints that render this

world splendid are not in the objects themselves, but in the light that shines upon them. Yet when we analyze this wonder-working light, we discover that it is but waves in the Æther of varying length that, breaking upon the retinæ of our eyes, produce the sensation we call colour.

'What dirty white blooms your geraniums have this morning!' said a man I knew to his florist.

'What geraniums?' inquired the florist.

The man pointed them out with his stick. 'These!'

'Oh, these!' replied the astonished florist; 'why, these are the very latest things in scarlet; the very brightest scarlet to be had in geraniums.'

And thus the man came to know that he was colour-blind.

In fact, what we see, hear, feel, taste, smell, in this old earth of ours is in exact accord with the power we bring to the seeing, hearing, feeling, tasting, smelling.

A group of people stood in an observatory. Amongst other things they were invited to look at the moon through the telescope.

The sweethearts declared that what they saw was a pair of lovers talking to each other across a stile. 'Oh, fie!' said the parson, when it came his turn to look, 'that is a beautiful cathedral with twin towers.' This is introducing a fresh factor; we often see what we expect to see, or what we are on

the look out for. Thus, when I taught students how to use the microscope, I had often been out of all patience with them for the little they could see, were it not that I remembered how I used to wonder at the amount my teacher said he could see where I could see nothing or next to nothing.

So it was with me when I sat down to write the introduction you are now reading. Before doing so I thought it might be just as well if I read the book first, lest I should be in the position of the man whose duty it was to present a Lord Mayor to a Royal Personage, and who began to do so before he discovered that he did not know the worthy magistrate's name.

However, thought I, it will be easy to scan the book, for the pictures tell me that I know most of what it can say.

Alas! I had not gone far before I found that I had been walking blindfold through the world of Nature. I knew, yes, a great deal. I had seen—a very little!

Then is it not true in a very quaint sense that Nature is 'the vicar of the almightie Lord'? Did not God Himself rejoice over the works of His hands, and pronounce them very good? Did not our Lord Jesus Christ bid His disciples go and spell G-O-D I-S L-O-V-E in the lilies of the field? Amidst all the toils of His redemptive work did He not deign to notice the price of sparrows in the market-place, and mark that to the buyer

of a double farthing's worth an extra sparrow was thrown in; and on this observation build the grand consolation that if one so valueless is not forgotten before God, 'Fear not therefore: ye are of more value than many sparrows'? Was not the Psalmist right when he wrote, 'The heavens declare the glory of God; and the firmament sheweth His handiwork'? And if I may be allowed to render the Hebrew a little more literally, in his words we shall learn another lesson—

'Day unto day doth pour forth speech,
And night unto night doth breathe out knowledge.
There is no speech, and there are no words,—
Unheard is their voice!
Yet through all the earth hath gone forth their voice,
And to the end of the world their sayings.'

Dr. Paton was working on one of the New Hebrides amongst some of the most degraded people. He required a tool. Hastily writing its name on a chip of wood he handed the chip to a native, asking him to take it to the house and give it to Mrs. Paton, who would then give him the tool he needed. The man asked what he was to say. Dr. Paton replied that he was to say nothing, only hand the chip of wood to Mrs. Paton. Whereupon the man refused to go. He said that Dr. Paton was trying to make a fool of him. When at length persuaded to go, he was successful in his errand, he ran into the village crying, 'Great is Missi, he makes the wood to speak!' And so may I not say the same of my friend, Edward Connold, that he 'finds tongues in

trees, books in the running brooks, sermons in stones, and good in everything'?

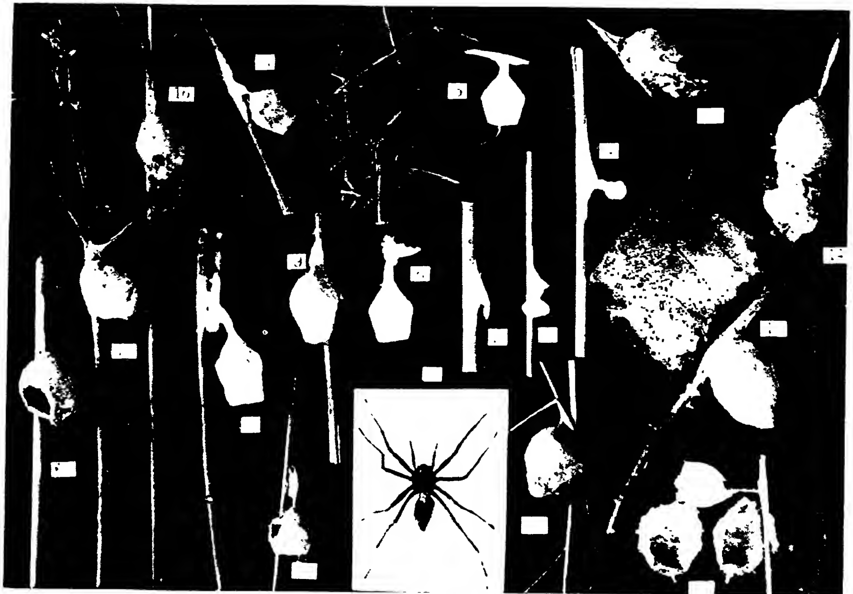
To the sailor the clouds have a meaning; the Moon is to him a prophetess; and the Sun in his course through the heavens, from the moment he springs fresh like Aphrodite from the waves until he retires to rest on his incarnadined couch in the glowing west, where dusky Night clad in sable robes bespangled with glittering stars draws the purple curtains round the dying monarch of the day, is to him one constant monitor. To the lonely shepherd, wandering o'er the solitary downs, the sky is fraught with messages of hope or warning, for is not 'a red sky at night the shepherd's delight,' whilst a 'red sky in the morning is the shepherd's warning'?

In fine, the heavens and the earth the Lord has made have voices that are calling, calling, calling with a persistent, insistent call. The whispering wind, the nodding flower, the gaily painted butterfly, the busy bee, the venomous wasp, the coiled snake, the queer inhabiter of the rocky pool, the swift swimmer in the deep, the perfumed blossom that scatters its petals far too soon, the quaint excrescence on an oak-tree's bough, the treacherous invader that threatens the stability of our homes,—these and many more have all a language of their own. But who will make us to understand their meaning? In an Eastern tale a man is granted the

power to understand the language of his court-yard denizens. I hear a young reader say, 'How jolly to know what the dog says to the cat, and what the spiteful reply she so vigorously makes; and what the cock says to his hens, and their reply!' Alas! his knowledge was no blessing to the man; what he learned made him unhappy. Now we do not want such knowledge. And so I guarantee that what Mr. Connold tells you will not make you unhappy. In this beautiful book he teaches us how to see, how to hear, how to feel; he teaches us how to interpret these sensations so that Nature is no longer silent towards us; and the long, low call, that waxes and wanes yet ever grows louder in our ears, is a call to know what by faith we already, perhaps, understand in some faint measure, 'that the worlds were framed by the word of God, so that things which are seen were not made of things which do appear'; a call to know that 'God is Love'; a call to learn in every marvellous structure, in every intricate adaptation, in every act of love by which the least considered of His creatures gives its life for its own, that God is Power, that God is Wisdom, and that 'God so loved the world that He gave His only-begotten Son, that whosoever believeth in Him should not perish but have everlasting life.'

St. Leonards-on-Sea.

A SYLVAN SPIDER.



THE FAIRY-LAMP-MAKING SPIDER AND EGG-SACS.

1. The spider. 2, 3, 4. The beginning of the sac. 5, 6, 7. The sac completed. 8 to 14. Sacs covered with mud. 15, 16. Attacked by enemies. 17. After the spiderlings have emerged. 18. The mud removed.

(All natural size.)

GLEANINGS FROM THE FIELDS OF NATURE

I

THE FAIRY-LAMP-MAKING SPIDER

SPIDERS are known to almost everybody. They are more frequently seen in the garden during the summer and early autumn (and, perhaps, indoors at spring cleaning) than during other times of the year. In the house they are much disliked, and usually meet death at the end of the broom. While it is admitted that spiders about the house are not welcome, and that they also suggest neglect, by spinning their snares in nooks and crannies, they often rid the occupants of the home of many troublesome flies. Spiders are strictly within the limits of animals beneficial to mankind, and they are one of the most powerful agents in checking the too rapid

multiplication of objectionable insect life. Their sustenance is almost wholly derived from the fluids in insects, for the securing of which a large proportion of the 550 British species spin webs or snares, though a great many overtake their quarry by chasing and leaping upon it.

No spider can fly. All are absolutely destitute of wings. Nature, however, is replete with compensations. The ability to spin, from the moment it issues from the egg shell, a silken thread is possessed by every spider. The thread is formed from a mucilaginous secretion produced in capacious organs within the abdomen, and forced at the will of the animal through about 400 minute apertures, known as the spinnerettes, situated at the extremity of the body. The fluid hardens immediately it comes into contact with the air, and that it also hardens under water is shown in the little bell-like nest made by the aquatic spider. The spider can also emit or stop the flow of material at pleasure.

This thread material is very elastic, and will bear a great strain. With it the animal makes a snare for its prey, and with

it immediately binds its capture as with cords to prevent escape; it is a lifeline when dropping from a dangerous height; and with it the mother weaves a cradle for her offspring. There are other uses also for the thread.

But spiders are crafty and fierce; they are also solitary in their habits. Their savage characteristics are such that cannibalism is common among them. Even courtship on the part of the male usually terminates in being murdered, and reduced to a shrivelled skin. Such traits induce a solitary existence. Exceptions are, however, found in the case of several South American species, one of which is social during the time of egg-production and cocoon-making; whilst another habitually lives in communities.

Although spiders have these peculiarities there are, nevertheless, some most interesting and delightful phases in their life history. Nothing about them is more remarkable than the ingenuity shown in the construction of the cocoon. The cocoon (more precisely known as the egg-sac) is a structure composed of silken threads of extreme delicacy, and a large quantity of the material is used

in its construction. The cocoon of the spider is for the purpose of enclosing and sheltering the ova. Some species carry the cocoon about with them; others suspend it in various situations and leave it for good; while again others watch over it until the brood hatches, and bestow upon the spiderlings some amount of attention.

The cocoons are of various colours, but mostly white and pale yellow. They are of various shapes, and differ greatly in size. Some are firm and compact, others loose and fluffy; some opaque, others translucent; while all are beautifully and skilfully made. So far as is known, the cocoon is always the sole work of the female, and is also her sole possession.

Of the cocoons made by British spiders, very few surpass in interest that of the species *Agroeca brunnea*, which forms the subject of the illustration. The campanulate shape, delicate appearance, and pure whiteness of its earliest condition, strangely contrast with the final stage in which such rare charm of form is hidden within a blob of dried mud.

During the months of May and June,

whilst you are leisurely walking along a cart track in a wood, little lumps of mud may be noticed adhering to the stems of grass or reed, which bear a very close resemblance to such as might have been splashed from a puddle in the wheel-rut. So close is this resemblance to what one would expect to see by the roadside, that possibly these objects are repeatedly passed without further notice. If, however, several are collected, and a comparison made, it will be seen that there is a similarity of composition and size which at once places them beyond the theory of being a drop of mud, such as the wheel of a cart, or the falling of a heavy stone in a muddy puddle, would have caused. Moreover they are not only attached to the stalks of grasses and rushes, but to thorny leaves of furze bushes, the twigs of small bushes of oak, birch, and broom; they are also found on heaths and commons, and attached to tree stumps, railings, and gates in fields and lanes; and on rank herbage in open spots in woods, especially if there be a little water trickling down a rut close by. They are usually found low down, very rarely at a greater height from the ground than

about two feet. It may be yet further noted that rain does not dislodge nor dissolve them, and also that, if immersed in water for several days, the size and shape remain unaltered, only the very smallest amount of earth falling off, and forming a thin film at the bottom of the vessel.

These lumps are mud-plastered cocoons. They first came under the notice of the writer in May 1893, when he found a large number in an open wood near Hastings. They have been observed in the same spot each summer since that year.

Agroeca brunnea is a spider of sedentary habits; to secure food it constructs a large sheet-like snare connected to a long silken tube, within which the animal awaits the coming of a victim. With incredible swiftness it darts from the tube, pounces upon the captive, overcomes its struggles, and secures it against escape by rapidly entwining silk around it. The spider then carries it to the end of the tube for an immediate or future banquet.

Upon what plan the spider works to form the silken portion of the cocoon, how long

its completion requires, and whether it is accomplished during daylight or at night time, and at what period of its construction the ova are deposited within, are points not yet fully understood. Obviously the sole purpose of the cocoon is to contain the ova, which generally number about fifty.

Referring now to the illustration, the spider herself will be observed at Fig. 1. Her cephalo-thorax (as the united head and thorax are named) and abdomen are small as compared with the length of her legs. There are eight legs. The two small projections from the head are the palpi. Although these palpi are small, they are extremely complex organs, and are of great value to the student of Areneidea, as regards their feature and form, in distinguishing between closely allied species.

But we pass from the spider to the interesting object she produces. Fig. 2 is a little piece of rush stem to which a quantity of silken material has been affixed by the spider, and left with a tiny pedicle only. At Figs. 3 and 4 we see operations carried a stage further. This stage of formation is not often seen, and it is probable that the makers of

these identical specimens were interrupted when they had advanced thus far, or that they fell a prey to some other creature. The next condition in which we are familiar with the cocoon is at Fig. 5, where it has arrived at completion, suspended from a needle of furze, and awaiting its coating of mud. Fig. 6 represents the same condition. The cocoon was attached at the stem of an old oak stub. They are more frequently seen like this at the close of the day than during the day time. The writer is of opinion that they are not constructed by the spider until sundown, and that for several reasons. One object is to ensure protection from predatory diurnal creatures, and birds also, the distinctive appearance (until mud-covered) being such that the cocoons would quickly be destroyed. Another probable reason for the nocturnal work is, that the dews of the evening will allow the spider better facilities for getting moist earth, if there be no water near, and finding it easier to plaster than it would be during the aridity of a mid-summer day.

It will be seen that the cocoon somewhat resembles an inverted wine-glass of antique

shape, or some modern-shaped bell—but in a very diminutive way—or a circular wheat-stack suspended at its apex.

At Fig. 7 we notice signs that the mud-plastering has commenced. At Fig. 8 the bell itself is covered with a thin coating, but the attachment portions of the pedicle are yet uncovered, while the bell has freedom from the grass stem. At Fig. 9 it will be seen that the bell is now bound to the stem, and the upper portions partly hidden with mud; while at Fig. 10 every portion of the original form is concealed, and two stray grass stems are also held fast. Figs. 10 and 11 represent perfectly finished specimens, and in both it will be noticed how much they resemble pyriform mud splashes. It should also be observed how the plastering has been carried around the grass stem in Fig. 10, and the bramble stem in Fig. 11, giving greater security and support. Fig. 12 is a specimen on the twig of a birch bush. It was more than two feet above the ground. How the spider reached it from the ground, carrying mud to cover it, without having to perform many long journeys, it is difficult to say. Perhaps she spun a

silken rope from the twig to the ground, down and up which she could travel.

Fig. 13 shows a cocoon on the stem of a reed (*Juncus*), and before it was mud-coated it must have been a veritable fairy lantern in a delightful situation. Fig. 14 is interesting because two cocoons have been placed close together, a very uncommon feature. At Figs. 15 and 16 can be seen small circular holes through which parasites have emerged. In Fig. 15 it is evident that the plastering had only just commenced, and a most interesting point here presents itself to the inquiring mind. Was the parent spider conscious that her ova were being consumed by the larva of a parasite, and did she desist without further expenditure of time, energy, and labour, knowing that her maternal efforts at protection would be useless? The absence of mud would in no way interfere with the development of the parasite and the annihilation of the progeny. Certainly there may have been other causes, the premature death of the parent being the most obvious.

The condition of Fig 17 indicates a more happy state of affairs. Here the brood of

spiderlings has safely come into existence, as the large hole and clean interior prove.

As soon as the spiderlings emerge they surround the empty mud-cases. Then each individual produces a gossamer thread which floats away and becomes attached to the surrounding herbage. Upon alarm or disturbance, the tiny creatures scatter each along its line, and the dispersion is like a little puff of smoke. After a little time they return to the case. Finally the case is deserted, each spiderling 'making tracks' of its own, and settling down to life, perhaps very far from the old home.

In constructing its cocoon the number of journeys the spider has to accomplish, carrying a load of mud, must in some instances be very considerable. Completed cocoons may be found which, as far as can be ascertained, are a long distance from a muddy puddle. One writer states that no moisture emanates from the spider itself, but that the mud is carried between the mouth parts in a very moist state, and that it is pressed into form with the feet. It is quite certain that the white silken case is not

rolled in mud, and then carried to the grass, stalk, or branch, and fastened.

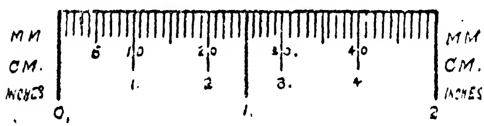
But, unless the mud be strengthened and rendered more adherent, rain or excessive moisture would speedily dissolve it, therefore, as the mud is spread on, the spider weaves in amongst it many strands of silk. This may be proved by attempting to crumble the mud to dust. The microscope also confirms this assertion, by revealing the silken threads.

There is yet another remarkable condition of the plastered covering, which is that, while self-adherent, it can be removed completely from the silken case, leaving that portion intact. At Fig. 18 this has been demonstrated.

Now why all this energy and hard work on the spider's part? It is merely due to the parental instinct and solicitude associated with maternity. A most beautiful cradle is provided by the spider for its offspring, but when complete its very beauty becomes its destruction; fears are entertained by the maker that it is too conspicuous, its attractions invite the spoiler, therefore its charms must be disguised, and to obtain this it is

transformed into an uninviting lump of dried mud. Alas! immunity from the spoiler is not always attained. From about one-tenth of the cocoons parasites emerge.

There are many other creatures in addition to the bee deserving the appellation of 'busy.' The spider is one. For it, the day is long and cares are few.



II

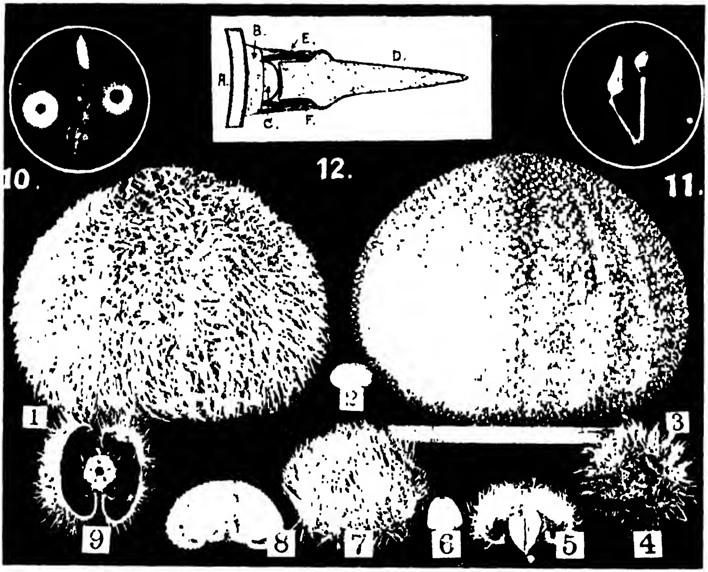
THE COMMON EGG-URCHIN

THE popular names of many marine objects are often peculiar. Some are amusing, many are far-fetched, some are misleading, a few are in fact misnomers.

For example: the 'seaweed' of ladies' hats and sunshades is not seaweed (*Alga*), but colonies of a beautiful zoophyte. 'Sea-grapes' are not products of a vine, but are clusters of black egg-capsules of the cuttle or sepia animal. The 'sea-mouse' is not a quadruped, but a large thick hairy worm or annelid. A 'sea-cucumber' is not a succulent edible vegetable, but a creature with an oblong leathery body which has a circular frill at one end. So, too, a 'sea-egg' is not an object deposited by some marine fowl, but an animal whose construction and mode of

PLATE No. 2.

THE COMMON EGG-URCHIN.



ECHINUS SPHÆRA, Müll.

1. A large specimen with spines. 2. A small specimen without spines. 3. A large specimen without spines. 4. The mouth and the five teeth surrounded by spines. 5. Section of test and dental apparatus. 6. The dental apparatus, "Aristotle's lantern." 7. Upper surface of the spines. 8. Interior of the test. 9. Interior of test showing upper surface of dental apparatus. (*All one-third nat. size*). 10. Photo-micrograph of ambulacrum and acetabula, x. 6., also 11. of Pedicellariæ, x. 6. 12. Diagram of median longitudinal section of spine and tubercle, x. 3.

life are replete with interest of a very high order.

But although these and many similar names are scientifically incorrect, they are often suggestive, and it would in some instances be difficult, if not impossible, to find another popular name more appropriate.

Two equally peculiar names for the sea-egg are the sea-urchin and sea-hedgehog. Most persons familiar with country lanes and woods know of the little quadruped which, when alarmed, rolls itself into a globular shape, and by so doing erects its coating of stiff and sharp-pointed spine-like hairs so that nothing can harm it. The marine creature whose life-history and structure will form the subject of this chapter, resembles the coiled hedgehog in the arrangement of its spines, and hence its name. But with that feature the analogy between the two creatures ceases. The spines of the sea-hedgehog or sea-urchin are always in a defensive attitude.

When the urchin perishes the spines fall off the shell or test (from L. *testa*, a shell), and in that condition the tests are known as sea-eggs. Small specimens may occasionally

be seen on the beach and sands. But the principal reason for the name of sea-egg is that among the ancients one particular species of sea-urchin, when in season, was a favourite dish, and was eaten both raw and cooked in various ways. They are still eaten by the poor in some fishing villages of Britain, but not so much as formerly. The use of the word egg is, however, scarcely warranted, for the test is never the same ovoid shape as a true egg.

The common egg-urchin, *Echinus sphaera* (of Müller), is one of the commonest of the six or seven British species of these animals. Together they form an order named Echinidæ, which is included in Phylum Echinodermata, both these words indicating animals with a hedgehog-like covering.

In making an examination of the structure of the test, the exterior will be considered first. It will be observed upon reference to Figs. 1, 4 and 7 of the illustration that the spines are so numerous that they conceal the test; that they point in various directions; and that in comparison with the size of the test, they are very short. They vary in

length, some being very small indeed, whilst none exceed 25 mm. in length and 3 mm. in diameter. They are longitudinally grooved, gradually taper from the base upwards, and terminate in a blunt point. The different character of the grooves or striations upon them are features by which the various species of the Echinidæ can be distinguished by the student.

The structure of a spine is singularly beautiful, and a very thin transverse section forms a charming object beneath the microscope. It bears a close resemblance to a corresponding section of any exogenous tree. A spine of the porcupine is very similar in its formation. The spines are arranged in definite rows, but these rows are not evident until a part, or whole, of the test is left quite bare. Fig. 3 has been denuded in order that the arrangement of the rows or zones of tubercles may be seen. The basal portion of each spine is concave, smooth, and glossy. This concavity receives the convex knob of the upper portion of the tubercle, and a ball-and-socket attachment is formed. The union of the spine with the test is maintained by

a circular band of ligament, one margin of which is fastened to the base of the spine, the other margin to the lower, and larger, portion of the tubercle; this ligament is encircled by parallel rows of muscular strands whose ends are attached in like manner to that of the ligament; these, in conjunction with the nerves, control the movements of the spine. Reference to the diagram (Fig. 12) in the upper central portion of the illustration, which is a medium longitudinal section of spine and tubercle, will help to elucidate these remarks. A is a portion of test; B, lower part of tubercle; C, upper part of tubercle; D, spine; E, muscle; F, ligament (after Leuckart).

All the spines act as jointless legs, by which the animal can progress along a flat or nearly flat surface; their action also enables the animal to bury itself in the sand, an operation it can perform with much rapidity.

The test is a hard and rigid structure, composed of carbonate of lime, in the form of numerous portions or plates of various sizes, which are in juxtaposition, but not

amalgamated at their edges. The material is secreted by a membrane which lines the interior of the test and permeates every suture of the plates, and while the thickness of each plate is gradually increased, its area is rapidly extended by the accumulation of the carbonate of lime upon its margin. Thus the expansion of every plate is equable, and the shape of the test is always the same, no matter how small or how large. The shape of the plates is pentagonal. There are other plates of different shapes upon the summit of the test, and around the mouth at the base.

The exterior of the test is completely covered with a ciliated outer skin or ectoderm, beneath which is a network of nerves, whose ramifications are very thorough and extensive, governing not only the movements of the spines, but those of the pedicellariæ. (These objects will receive explanation later on.) The entire surface of the test is thickly studded with small rounded calcareous knobs or tubercles, which are smooth and glossy, and are elevated upon larger bases of hemispherical shape, and arranged in definite zones with great regularity.

The test is composed of twenty rows of plates, pentagonal in shape, arranged in ten alternating zones, each zone consisting of two rows of plates. In five of these zones the plates, although small, are formed by the fusion of several smaller plates, named pore plates or ambulacral plates, each being pierced by twin holes, through which two delicate membraneous tubes pass and unite to form one tube-foot or ampulla. These ampulla tubes are branches from a radial canal of the water-vascular system within the test. These zones are known as the ambulacral areas. In the other five zones the plates are large and not perforated; these are termed the inter-ambulacral areas. The main part of the test is made up of these ten zones. These features may be recognized in Fig. 3.

The shape of the test is subject to slight variation. Some specimens are spheroidal, some discoidal, others somewhat oval, but mostly they are more or less globose with poles flattened, the lower pole much more so than the upper. They will bear considerable pressure without breaking, and are not easily fractured. Some specimens in British seas

attain a very great size, the largest being generally found around the Irish coasts and off the South-West of England and Wales. They get into cray, lobster, and crab pots, and are also brought up in the trawl-net. Fig. 2 is a very small specimen. Fig. 3 may be regarded as a large and perfect specimen. It measures 11 cm. high, 42 cm. in girth, and 48½ cm. in circumference. It was obtained from a crab-pot off Land's End. Fig. 7 is the largest the writer has been able to obtain from the Hastings trawlers.

The interior of the test is smooth, and shows clearly the shape of the plates and their arrangement. If it be held to the light the ampullæ holes will be easily observed, and it may also be noted that the perforations are in a diagonal direction, and not at right angles with the growth of the test. Figs. 5 and 8 show portions of the interior of a test. In Fig. 5 is seen half of the mandibulatory apparatus, in Fig. 8 three of the five processes to which the apparatus is firmly attached by the muscles. These processes or staples stand in a slightly oblique manner, are quadrangular in form, and have the lower

margin firmly fastened to the interior of the rim of the mouth circle. They are perforated with a wide oval aperture in the centre, through which passes a radial nerve trunk and a radial water canal.

Fig. 4 represents the under surface of the animal. In the centre can be seen five small white marks, something like an asterisk in shape, black between the rays, and surrounded by a belt of light colour. The light portion is the integument which holds the lower parts of the dental apparatus in place. The asterisk mark is the point of convergence of the teeth. These five polished, pointed teeth are the principal parts of a most remarkable object known by the fanciful name of 'Aristotle's lantern.' It consists of five three-sided, isosceles-triangular, bone-like pieces or sections, united with their apices pointing downwards, and forming an inverted cone. This may be seen in section at Fig. 5, and complete with apex uppermost at Fig. 6, and its flat top in Fig. 9. The latter figure is an urchin cut open from above downwards, and in the actual specimen all the internal parts can be traced. Each section forms a kind of

jaw or sheath for a long slender and curved tooth. The two inner sides of each jaw are quite flat and finely striated across, the edges being pectinated like a comb. The teeth are hard and enamelled at the points; they meet at the tips at one point, and are powerful in their action of biting and tearing food. The points are chisel-like, very sharp, and are kept so by the wearing away of their tips, new material being formed at the other end. The teeth are very much in shape like the gnawing teeth of rats, mice, and similar rodents, and grow in like peculiar manner. Each tooth is moved by a double set of muscles, the weaker to draw it upwards, the stronger to pull it down. All the parts are so firmly held together by muscles and ligaments, that it can be easily removed from the test without separation taking place.

The food is comminuted within the dental apparatus, and passes immediately into the œsophagus, and through that into a very large, slightly convoluted intestine, that occupies the greater proportion of the test; its termination and outlet are at the opposite pole to that where the mouth is. The ovaries

also occupy a considerable space within the test. They are five-lobed, and when full of ova, which usually is the case in the autumn, the animal is considered suitable for food.

The water-vascular system of an Echinus is upon the same plan as that of a star-fish. The water enters the madrepore on the summit of the test, passes through a long tubular canal, until it reaches the upper part of the dental apparatus, where it branches off into canals to supply the numerous tube-feet and their tiny reservoirs or ampullæ.

The tube-feet are variously known as sucking-feet, pedicles, pseudopodia, and ambulacra. They are long, fleshy, muscular, and flexible tubes, which can be distended with water at the will of the animal. They are partly contractile, but cannot be withdrawn into the test, because of the double hole and a calcareous expansion of the extremity known as the acetabulum. There are many hundreds of ambulacra, the extremity of each one acting as a sucker. In order that an adequate idea may be obtained of the delicate structure of this saucer-like disc, a pocket-lens or a microscope must be employed. At

first glance it looks like a tiny white wild rose, but a high-power lens is necessary to reveal its exquisite form, chaste pencillings, and the digitate expansion of the margin. It can also be seen that there are five (some have six, others seven) plates, in shape like petals of the rose, united at their sides. A little hole is in the centre, over which a membrane of extreme delicacy is stretched, the whole forming a most beautiful and effective sucking-disc, which can be protruded beyond the tips of the spines. With a combination of these acetabuliform ambulacra the Urchin can climb the sides of rocks and boulders, and hold on with great tenacity.

Fig. 10 is a photo-micograph of three acetabula; that on the right hand shows the under surface, on the left hand the upper surface, in the centre the profile with dried tube attached, the lower portion of which is one of the twin tubes which passes through a pore hole.

But there are other unsuspected objects of great fascination revealed under magnification, the most delightful of which are the peculiar little forms known as pedicellariæ, which are

scattered in many hundreds all over the surface of the test and around the mouth. In nature they do not exceed 4 mm. in height. They consist of three parts; a long, slender, opaque, glass-like rod, the basal end of which is articulated to the test, and to the upper part of the rod is attached a short flexible tube named the neck, which supports the portion known as the head.

The heads are of four different shapes; two are shown in the photo-micrograph, Fig. 11. The shape which is most numerous is ovoid, and bears some resemblance to an acorn without the cupule; the other kind is like a tripod with the pointed ends closed together and directed upwards. Each head consists of three separate portions, capable of independent movement, united to each other at their bases, and very finely serrated along their margins. Those of the ovoid form are pointed elliptically, convex externally and concave internally. The material of which they are composed is calcareous, moderately hard, but brittle, and vitreous. They open and close continually, snap at everything, seize small creatures and objects,

and quickly turn themselves in any direction. Their chief uses seem to be for the purpose of defence, for the removal of particles of dirt, and the destruction of small unwelcome visitors among the spines.

The food of the sea-urchin consists of seaweed, small crustaceans, and other tiny creatures which roam over the floor of the ocean.

III

THE DARK-BROWN ANT AND ITS HOME

IF the mind is intent upon the investigation and study of Nature, no other form of progression is comparable with leisurely walking along a country road and carefully examining the objects. Indeed, the pedestrian possesses many and great advantages for practical research not obtainable in other ways.

Ofttimes one will pass along a road that has high banks on one or both sides. Such banks may be covered with small bushes and rank vegetation; they have a fauna and a flora entirely their own of the greatest interest to the naturalist, who well knows how they repay investigation. Many hours of most careful search may with great profit be devoted to a space so small as one square

PLATE No. 3.

SMALL ANTS.

INTERIOR OF A FORMICARIUM OF THE SMALL DARK-BROWN ANT, *Lasius niger*, Lubbock

In situ By roadside. *(One fifth nat. size.)*

yard of a roadside bank, and a rich fund of facts accumulated.

During a saunter along the road we shall notice at all seasons of the year, but especially during July, August, and September, small dome-shaped mounds of earth, varying in dimensions from that of an inverted pudding basin of ordinary size, to one measuring two feet or more in diameter. These mounds are more easily discovered on a bank where grasses, marguerites, and other small plants are growing, than when occupied by larger vegetation. The luxuriance of wild flowers and grasses during the summer months conceals the mounds somewhat, and they are not so distinctly seen as in the winter and spring; but they are there all the same, and are now steadily increasing in area, and will continue to do so until autumn chills arrest the cause. Moreover, if the road runs from east to west, these mounds are generally more numerous on the bank facing the south than on the bank which has a northern aspect. Why should this be so? The reason will disclose itself as our investigations proceed. There are, however, considerable areas

of the bank, and long stretches of it, in which no mounds are seen, and many by-roads and lanes have none at all; while in some spots and districts they are very numerous. ९,९९४

Assuming that we are investigating one of these mounds while standing in front or resting upon the ground beside it, the first thought that arises in the mind is, of what is it composed, and how was it formed thus?

That it is composed of earth there is no difficulty in deciding. Its form is familiar to all who study the fields, in which may be seen numerous earth mounds, so well known to most girls and boys as 'mole heaps.' The observant mind will, however, speedily detect variations between the two objects. This upon the bank has many stalks of grasses, and stems of flowers and other plants growing up through it; those in the field are quite destitute of any vegetation upon them. The surface of this consists of very small, almost equal-sized, granules of earth, which will easily pass through the meshes of a fine sieve; not so the earth in the field. The size of the mounds in the field is very uniform, although not absolutely constant; those on

the bank are very variable, some small, others large. Those in the field we are sure are thrown up by the moles, as they burrow their way under the grass in search of food; of this close to us we may be at present uncertain of its origin. Those in the field can be easily scattered—try it with your foot, a child even can level them with perfect ease. Not so this on the bank, a little of it can be pushed aside, but not all. Moreover, moles very rarely (if ever) burrow in inclined planes such as high banks. We could, therefore, without disturbing the mound at our side, satisfy ourselves that these bank mounds are not the work of moles.

These comparisons may appear prolix, but they are not superfluous. A prominent member of the Criminal Investigation Department of Scotland Yard once said that 'the mere power of observation is of no use without a keen deductive faculty.' Would that all students of Nature would apply the principle to their investigations!

We proceed to investigate, and a very brief examination will reveal the origin of these mounds, and the agent producing them.

First, a quantity of the herbage is cut away, with a large pair of scissors, from one side and off the top of a mound. While this is taking place numbers of small ants will doubtless make their appearance from the domed portion, and show their displeasure at interference by rushing about in great haste, up and down the herbage, along the scissors, and even up your arm, with remarkable agility.

It will now be seen that the dome consists of an outer covering of very small disintegrated particles of earth, of nearly uniform size and shape. With a knife, whose blade should not be less than ten inches long, we cut away vertical slices, until about the middle of the structure is reached, and there will be presented a view such as appears in the accompanying illustration. The diameter of the face-area of the specimen was twelve inches, and it is quite typical of nests or formicaria, tenanted by at least two common and widely distributed species of ants.

We have then before us a small formicarium of the dark-brown ant, *Formica nigra* or *Lasius niger*. About half of its bulk has been cut away, so as to reveal the honeycombed

nature of the passages, and the cells. Before it was disturbed it was entirely surrounded by grasses and various small plants which almost obscured it from view. The lower third of its area is solid earth. This, had not the site been disturbed, would, as the number of the inhabitants increased, have been riddled with passages and cavities. The earth removed in the process of excavation would have been brought to the dome of the structure by the workers in the form of small granules, and the height thereby increased. The upper third or domed portion of the structure is built by the ants with these earth granules in the form of a labyrinth of passages, the walls of which are very thin and brittle; but the grass and plant stems which grow through the structure are of some value as supports.

The population of this formicarium at the time of examination was judged to have been about 3000. *Lasius niger*, in common with several other species, is both a miner and a mason, and builds its home not only on road-banks, in meadows, and on railway cuttings, but in kitchen and flower gardens.

At various parts of the galleries are enlarged cavities in which lie the ova, larvæ, and pupæ. It is not easy to distinguish these objects in illustration, although they were *in situ*; they were very small in nature, and the formicarium itself is only one-sixth natural size. Hundreds of ants were running all over the face of the section, but they also are too small to be recognised, except in the original photograph. Their natural size is 5 mm. long. The nurseries are usually in the centre of the mound, where the earth is hard and solid, but not dry. The ova are exceedingly small, and rarely to be found on that account. The larvæ vary in size up to about 8 mm. in length, and consist of twelve segments.

When changing into the next stage the larvæ spin cocoons. These cocoons are of four sizes. Out of the least will emerge the small workers; from the next larger come the males. The cocoons of the large workers are only slightly larger than the last, but those of the females are the largest, and are about three times larger than the smallest. The cocoon of a female of *Lasius niger* is 7 mm. in its longest axis, the shape being cylindrical, and

the appearance straw-colour. The cocoons of ants are sold as bird food under the misnomer of 'ants' eggs.'

Sunshine and heat are essential to these insects in all stages of life, hence they prefer a sunny aspect for the formicarium. The intense heat some tropical species can endure is wonderful; some are able to enjoy such heat from the sun as kills beetles in a few minutes.

Along the banks, many formicaria of the two species of ants previously mentioned occur almost side by side, but the members of one colony do not appear to molest those near them.

A formicarium under ordinary conditions contains three kinds of ants: males, perfect females, and imperfect females or workers, some of which are larger than others. In comparison of numbers the workers far surpass the other kinds combined. The three kinds vary in size and colour. In those of *Lasius niger* the males and workers are about the same size, but while the workers are yellow, and are wingless, the males are dark brown and have four wings; the females also have

wings, are reddish brown, with a few stripes of lighter colour on abdomen and thorax, and are twice as large, except as regards expanse of the wings.

Life in a formicarium during July is full of activity. The number of workers is daily increasing, in consequence of the pupæ emerging as perfect insects; excavations are continually being extended; and in the course of a few weeks the solid portion of the earth, seen in the lower part of the illustration, would have become like that immediately above it.

The ant is a true insect, and, in common with other insects, its body consists of three well-defined portions: the head, with its various and important organs; the thorax, to which is attached the head in front, the abdomen behind, and two wings and three legs on either side; and the abdomen, which contains various other organs of the system.

Of all insects the ant is, perhaps, the most widely known, and the one whose work and ways have been most thoroughly studied. One is not forgetful of the claims of the honey bee, but the study of ants appears to

be of greater antiquity than that of bees, and mention of them and their ways is found in writings of all ages.

Ants spread all round the earth in a broad belt, reaching degrees of latitude far removed both north and south of the Equator. In tropical and semi-tropical countries they are not only extremely numerous, but attain their maximum size.

Very few creatures afford such wide and deep interest—an interest which centres upon their habits. They are regarded as the most gifted of all insects, and by some naturalists are considered to rank next to man as regards their intelligence. Their reasoning powers are extraordinary. They are essentially social insects, and the manner in which they work in concert under leaders is marvellous. Their ingenuity in accomplishing whatever they wish to perform is almost incredible. They build curious and complex structures, or pile up heaps of small pieces of sticks, twigs, and leaves, or excavate galleries and tunnels in the earth covering large areas, and extending considerable distances in all directions.

Amongst the foreign species there are

some whose ways, habits, and homes excite the wonderment of all who see them. Some are destructive to the works of man, others are beneficial to him, rendering great service. The ants of the British Isles are quite as wonderful in their ways, but being much smaller, less numerous as individuals, and living in much smaller communities, they are less noticeable than they might otherwise be; moreover they perform no benefit to man, such as do the driver ants of Africa.

In this country there are about thirty species of ants, three of which are well known to all students of insect life: the common wood ant (*Formica rufa*), which piles up heaps of small twigs, etc., in woods; the small yellow meadow ant (*Lasius flavus*), whose formicaria may be seen in almost every British district; and the little dark-brown garden ant (*Lasius niger*), so abundant in many gardens and on grassy banks, whose formicarium is here described. These last two species are not very powerful, but what they lack in that respect they supply in numbers. Both species construct enormously populated cities. The dark-brown ant, however, is

more robust and more pugnacious than the yellow species.

The head of an ant is large in comparison with the other divisions of the body. The two mandibles, which work laterally, are large and powerful, each having four sharply-pointed cusps on the inner margin.

Ants are mostly carnivorous, but delight in sweet juices, honey, jam, sugar, and such like. Their foraging and plundering expeditions are sometimes very extensive, and they travel long distances away from the formicarium, and return with unerring certainty.

None of the British ants store food, nor do they make combs or cells for their larvæ to live in. They are of most industrious habits, and for ages past have been the synonym for diligence. They run with astonishing swiftness. A part of their anatomy differs from that of wasps and bees, in that the workers have no power of stinging; but the bite of the larger species is both sharp and irritating.

Ants are known in rural districts by the name of emmets, a word often pronounced 'am-its.'

IV

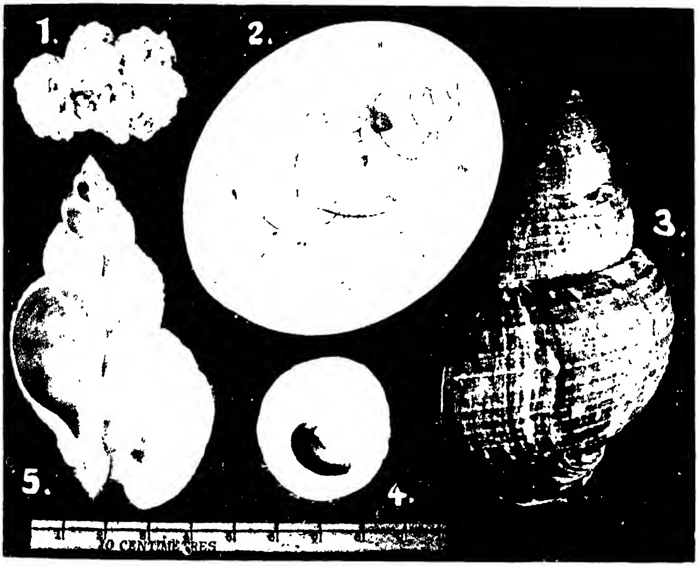
THE COMMON WHELK AND ITS SHELL

AMONGST the many creatures which contribute to the great and continuous harvest of the sea the whelk is conspicuous, on account of its abundance. It is familiar to most dwellers in sea-coast towns and visitors to the seaside, whilst it is also well known to the humbler classes in great centres of population. In inland towns and villages it is not so familiar—in some parts, indeed, it is seldom or never seen.

Next to the oyster, the whelk is more largely consumed as an article of food than any other shell-inhabiting animal; it is, however, of a more plebeian character than the oyster. In some districts, especially North England, the mussel is perhaps more extensively eaten, this being accounted for by the

PLATE No. 4.

THE COMMON WHELK.



THE WHELK. *Buccinum undatum*, Linn.

1 A small cluster of egg-sacs. 2 The body of a whelk. (The shell in outline only.) 3. A shell. The type of a coiled univalve molluscan covering. 4. Median transverse section of a shell 5 Median longitudinal section of a shell

(*Two-thirds nat. size.*)

fact that a rocky coast is more favourable to the finding of mussels than of whelks.

The whelk, like some other marine articles of food, is principally obtained by dredging. A dredge and the method of its use is briefly described in the study on FLUSTRA. Whelks are also caught in crab and lobster pots, within which they creep for the bait-food; but those trawled from the sandy bottom of the sea are considered 'cleaner' and more palatable. They are also obtained in great quantities when dredging oyster-beds, where they commit almost as much destruction as does the common star-fish.

The whelk may be obtained all the year round, but the summer season is the time of greatest plenty. As an article of food, when boiled, it is distinctly wholesome and nourishing, deserving higher favour than it appears to enjoy.

A whelk shell, either whole or in a more or less broken condition, is known to almost everybody. A shell containing the animal alive is not often seen on the sands or beach. Under natural conditions whelks do not readily crawl on hard surfaces, but if placed

on the sands, in a very short time they burrow out of sight.

Like many other humble and sometimes much-despised animals, the whelk has, to even a superficial observer, many features of great interest in its economy. These features may be divided into two groups — those pertaining to the physiology and movements of the animal, and others concerning the structure of the shell and its relation to its producer and occupant.

Firstly, we will direct our inquiries (somewhat superficially, however) towards several of the organs and their functions, and note their effect upon the growth and movements of the body as a whole. And, that these remarks may be better understood, the reader is invited to consult the oval portion in the illustration, which is a diagrammatic representation of a whelk as seen in the act of creeping. The position and shape of the shell are given in outline only.

The greater portion of the body within the shell is enveloped by a skin-like sac known as the mantle. It is a most important covering. One part of it is deeply grooved,

and forms a depression, named the 'mantle cavity,' within which are several important organs, the principal being the gill. Upon the surface of the mantle are the glands which secrete the shell-forming materials. These glands are so numerous and active, that if a shell is damaged or broken, new material can be produced to repair the injuries; but they have not sufficient secretive power to form an entirely new shell, should the original one be removed.

The letter L directs attention to arborescent markings within five apical whorls of the shell; that is the liver. Next to it is H, the heart, from which there branches off towards the left-hand a portion, Gi, terminating in a sharp point and cut longitudinally, so that its interior can be seen. This is the gill or ctenidium—a comb-like breathing organ. It is composed of rows of plates between which the water circulates, and it serves the purpose of a lung. Sy is the syphon. It is a spout-like continuation of the mantle, and through it the water passes to the gill plates and other organs. The tentacles, TT, are two in number, each

having an eye, EE, at the base. Although the eyes consist of cornea, lenses, retina, and optic nerve, the power of vision is not great. Between the tentacles is the proboscis, P. It is a miniature trunk, which can be unsheathed from the base. It is the organ from which the food is conveyed through the long and tubular gullet, Gu, to the stomach. The stomach, St, is more capacious than is apparent. It is reflexed parallel with the axis of the gullet, in the form of an intestine, terminating at I. Between these two portions is shown the position of the ovaries, Ov.

At the extremity of the proboscis the tongue is situated. It is variously described by writers as the odontophore, radula, toothed band, and lingual ribbon. Radula appears to be the more general name. This portion is a most wonderful structure. It consists of a ribbon of chitinous or horny membrane, upon one surface of which are situated siliceous teeth, with adamantine points, and of two patterns. They are placed in three parallel rows, each row quite separate from that next it. The teeth of the centre row are very like

a small comb with six deep serrations, producing seven coarse but very sharp points or cusps. Those forming the marginal or lateral rows are somewhat triangular in shape; the apex of each triangle fits into the base of that immediately behind it, which base is deeply but irregularly grooved, forming four long as well as very sharp cusps, the outer cusp being sickle-shaped and curving towards the centre of the radula. Consequently there are fifteen cusps in each transverse row, and as there are one hundred rows in each radula the animal's power over its food is very great. As the teeth in front wear away, the radula moves forward, bringing new teeth into action.

We may here digress a little, to seek a reason for the existence of these teeth. What is the food of the whelk? To a great extent it is a carrion-feeder, but it also exists very considerably on oysters, limpets, mussels, and other molluscs. Oftentimes empty valves of such animals may be seen on the beach or rocks, in which there is one small neatly drilled hole. That hole was made by the action of the teeth of the radula while the occupant of the shell was alive, and so soon

as the perforation was completed the proboscis of the whelk was thrust through it, and the contents of the shell consumed by the depredator.

Such food needs assistance in deglutition, and we see in the diagram at Sg a pair of salivary glands for the purpose. Close to them are three stars united by threads; these are the principal nerve centres. Letter F points to the foot. This portion in no particular corresponds with the human foot; it contains no bones, and is not divided into parts. It is a long, somewhat broad muscular creeping disc, spreading from the ventral surface of the body. Its action impels the creature in a steady and continuous gliding manner, seldom performed except when covered with sea water. Op, the operculum, —a little lid or cover—is a horny thin plate securely attached to the distal extremity of the creeping disc. When the animal retreats within the shell, the operculum fits the aperture and completely closes it.

The protraction and retraction of the body is by means of a special muscle (not shown in the diagram), one end of which is affixed

to the body, the other to the interior of the shell; its elongation producing the former movement, its contraction the latter.

The shell itself now claims attention. It is the type of a marine univalve coiled shell, within which the whole of the animal can be contained and protected against injury. It is a solid house, and an impregnable fortress for the inhabitant, secured to its own use exclusively by the perfectly fitting lid.

Although the shell is so abundant, few persons are aware of the beautifully symmetrical form it assumes. The scientific name of the whelk is *Buccinum undatum*, and both words are connected with characteristic features of the shell. The first is the generic term: it is the Latin name of a shell-fish used in dyeing, and is connected with the Latin for a trumpet or horn. It should be remembered that many ancient horns were of a spiral form. The word *undatum* (*unda*, a wave) is used in reference to the waved or ribbed markings of the shell. The formation of the twists or whorls of the shell is that known by the conchological term of ventricose, *i.e.*, bellied, or swelling out in the

middle. The specimen on the right-hand side of the illustration completely fulfils these designations.

There is something else to be noticed in regard to the external nature of the shell, viz., the general brown colour, with here and there white places. This colour is caused by the outer covering, the horny layer or periostracum. It is composed mainly of horny substances, and serves to a considerable extent as a protection against the erosive action of substances in the water. It varies greatly in its different qualities and textures. On some shells it is thick, on others thin; that on the whelk is of medium thickness.

On the left-hand side of the illustration is a vertical section, revealing the plan upon which the shell is constructed. It will be seen that it is spirally coiled upon a central pillar, which is known as the columella (or little column). It is the axis around which the whorls are coiled, and is formed by the whorls adhering to each other. In some shells it is hollow, but in most kinds, the whelk included, it is solid. The lower central figure is a transverse section at a median line of

the shell's axis, looking into the apiacal portion. The graceful curves, the symmetrical outlines, and exquisite proportions of each, should be noted. In nature the appearance of the interior is that of a most beautiful translucence, which is produced by a special layer of material, the nacreous.

The shell is hard and calcareous, being composed of carbonate of lime with an admixture of organic substance named conchyolin. The shell also consists of three distinct layers: (1) the inner or nacreous, the mother-of-pearl layer, so beautifully soft and smooth to the touch, and glossy in appearance; (2) the prismatic or porcellaneous, which is formed in a different manner, and composes not only the central but the greater proportion of the shell; and (3) the external or horny layer, previously mentioned.

One more feature requires notice, before our examination of this most interesting mollusc is concluded. It is the manner in which the animal begins its existence.

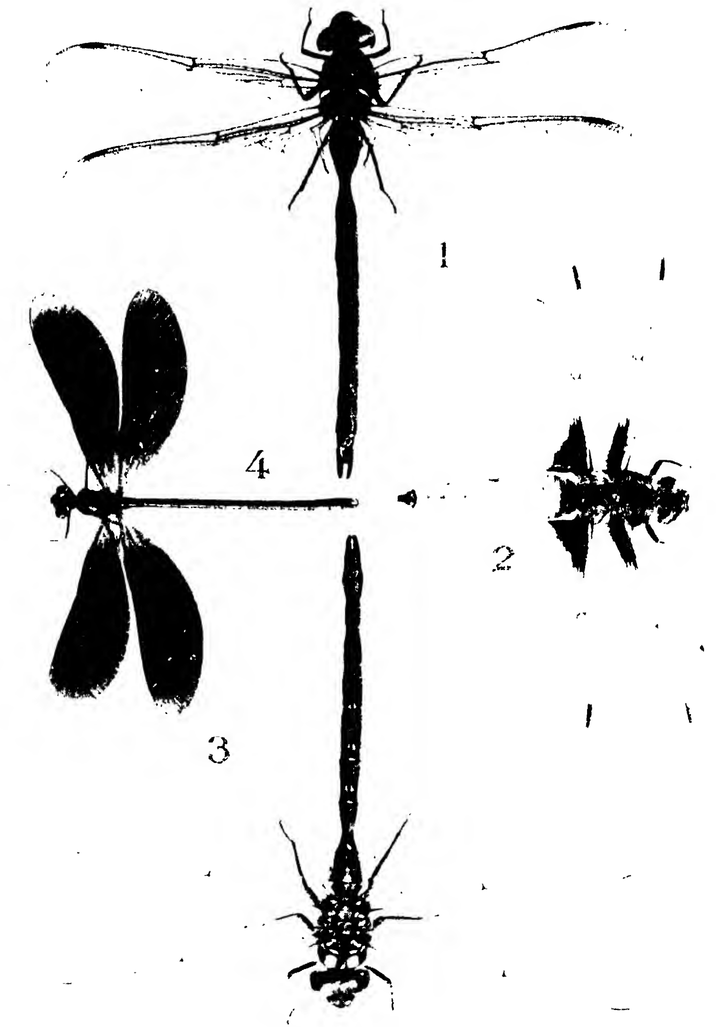
Upon the beach, after a rough sea early in the year, there may often be seen irregular-shaped masses of a substance bearing a close

resemblance to pieces of dirty sponge. Upon close examination it is seen that they are composed of little horn-like cases, each having a flat and a convex surface, united at their margins; and so firmly are the cases joined to each other that they cannot easily be separated. They are not solid, but contain the embryonic forms of future whelks, of which there is an average of seven in each case. These are the egg-capsules of the whelk, and the enormous bulk of some clusters is remarkable when compared with the animal which produces it. A small cluster (one-fourth nat. size) has been placed in the upper left-hand corner of the illustration. It is composed of upwards of seven hundred sacs, and from it there issued about five thousand young whelks.

Need we be surprised that whelks are abundant when one parent can produce so numerous a family?

FOUR BRITISH DRAGONFLIES.

PLATE No. 5.



1. *ÆSCHNA GRANDIS*, Linn. ♂ 3. *ÆSCHNA CYANEA*, Müll. ♂
2. *LIBELLULA DEPRESSA*, Linn. ♂ 4. *CALOPTERYX VIRGO*, Linn.

(*Natural size.*)

V

BRITISH DRAGONFLIES: FOUR SPECIES

THE brilliant, sunny, and intensely hot days of July and August are seasons of joy and exhilaration to the denizens of the insect world. Foremost of that countless host who revel in great heat are the dragonflies.

Their gorgeous colours, slender and graceful bodies, expansive wings, and remarkable rapidity of flight, cause them to be amongst the most noticeable of winged insects. Often, while walking through a copse or along a country lane, these attractive creatures may be seen going from place to place, with a swiftness equalled by some other insects, but surpassed by very few. The course of a country ramble will also bring us to the flower- and grass-bedecked margin of some

slowly meandering stream, or the reed and rush borders of a boggy lake or pool. These are the favourite haunts of most English dragonflies. It is in such spots that they obtain the greatest amount of food. Here, too, the female deposits her ova; and beneath the surface of such waters the early stage of dragonfly life is passed. But, being endowed with large and powerful wings, they are often seen far from any water.

Although very bold and fearless insects, they are somewhat difficult to capture, even with a properly constructed insect net. For it needs a keen eye to follow their movements, and a rapid stroke of the net to effect a capture. If an unsuccessful attempt be made to take a dragonfly, patience on the part of the collector may ultimately be rewarded with success, for some species have a strange peculiarity of returning to a particular twig, or of flying to and from a given spot. Searching for the imperfect forms, or nymphs, in their muddy aquatic haunts, is attended with inconveniences and difficulties, and the feeding and rearing of such captures is not always followed with success.

Very few dragonflies are seen on the wing except during fine sunny weather, and when the wind is not from the east. Sometimes one of the larger species may be found hawking for food in the twilight, and on warm, although cloudy, days a few of the smaller species flit about amongst the aquatic plants. The higher the temperature and the calmer the atmosphere, the larger their number and the greater their celerity.

In the British Isles there are thirty-seven indigenous species of dragonflies, and ten other species which are exceedingly rare and of doubtful authenticity, two or three probably being only visitors from the Continent.

Of the large British dragonflies two species are about the same in dimensions and of similar habits. They are shown in the illustration—Fig. 1, *Æschna grandis*, and Fig. 3, *Æ. cyanea*. The expanse of the wings of the latter is, however, often from 4 to 6 mm. in excess of that of Fig. 1. Both are extremely handsome insects, but in quite different ways. The wings of Fig. 1 are semi-transparent, suffused with a light sienna colour; those of Fig. 3 are hyaline, with a very pale sepia

suffusion, and while its thorax and abdomen are richly ornamented with variously shaped spots of blue, yellow, and green, on a dark-brown ground, the same parts of Fig. 1 have only a few blue and yellow spots on a russet-brown ground. The wings of both species are reticulated in a marvellous manner, forming, between the main nervures, an intricate meshwork of membraneous cells. Under magnification it can be observed that all the nervures and cross veins are studded on both surfaces of the wing with short spines, which point in the direction of the extremity of the wing. Their presence may also be demonstrated by drawing a wing between the fingers: away from the thorax the feeling is smooth, but in the opposite direction the resistance is very sensible, owing to the spines. The wings of both species are so clear that in the illustration eight of the twelve legs, although beneath the wings, are quite distinctly seen.

Another beautiful dragonfly (Fig. 2) is named *Libellula depressa.* There are four other species of similar appearance, and discrimination is at first a little difficult. All

are very handsome insects. *L. depressa* is perhaps the most brightly coloured. It is plentiful throughout England, and appearing early in May, is to be found during the whole of the summer. The abdomen of the insect is broad and flat, terminating in a point, thus giving it some resemblance to a spear-head; the colour is bright blue in the male, with a few small lateral yellow spots, and greenish yellow with yellowish margins in the female. The wings are hyaline with dark-brown patches, oblong on the fore wings, and triangular on the hind wings. Fig. 2 is a male.

A favourite habit of this dragonfly is to settle upon a particular reed or piece of stick in a stream or pond, which may be some distance from the bank, or nearer shore, yet in an inaccessible spot for the collector. It will fly off when disturbed, and go some distance away, but returning to the same or a similar spot in due course. It is very wary, and its capture requires much perseverance.

Another type of beauty is represented at Fig. 4, in the male of *Calopteryx virgo*. By many entomologists this is considered the most beautiful of British dragonflies. When

fluttering in the sunshine, both sexes, the males especially, are most resplendent objects, the normal coloration of whose wings is a deep metallic blue, the head and abdomen being the same; the wings of the female are a russet colour, her head and abdomen a brilliant peacock copper. The meshwork or reticulation of the wings is exceedingly fine, and with the aid of a lens it may be observed that the colour is upon the nervures, and not on the intermediate portions.

The form and the habits of *C. virgo* are different from those of the dragonflies shown in Figs. 1, 2, and 3. Upon reference to the illustration it will be seen that the legs and abdomen are more slender and graceful; the wings also are of a different shape. *C. virgo* flies in a languid and uncertain manner along the edges of streams and rivers that are thickly clothed with vegetation, and is not at all difficult to capture. When at rest the wings are closed after the manner of butterflies', and in that condition it may easily be taken between thumb and finger. This dragonfly is subject to much variation from the normal coloration of the wings. It is a

widely distributed species throughout Britain, and it may be seen in its native haunts on any sunny day from early May until the end of July, especially in the South of England.

Dragonflies have at least two other popular names. One is 'horse-stingers.' The notion in many a rustic's mind is that they inflict pain on horses and cattle by stabbing them, as does a wasp or a bee. It is quite erroneous. There is no sting or any instrument like one. When the creature is held by the wings, it will turn its abdomen about in a threatening manner, and also open and close its mandibles, which, of course, will pinch any soft substance; but apart from that all British dragonflies are incapable of hurting man or beast.

Another name is 'devil's darning-needles.' This term is perhaps more applicable, the long tapering cylindrical abdomen having some resemblance to a very thick needle, the eye being represented by the space between the caudal appendages. These are clearly visible in Figs. 1, 3, and 4.

The term 'dragonfly' is indeed appropriate, not only on account of their brilliant, scaly

tegument, but because of their predaceous character amongst other insects, and their voracious appetite. These characteristics are manifest from the time the nymph hatches from the egg, until the imago emerges from the puparium, and then, in, if possible, a more pronounced manner throughout the whole of its aërial existence. Whether they themselves fall a prey to other creatures is not certain.

The early conditions of dragonfly life are very dissimilar from those of its perfect state.

When the creature emerges from the egg it is known as a nymph, and that name it retains until it appears as a winged insect. It has not the true maggot or larval, and chrysalis or pupal, stages, common to most insects, and consequently a dragonfly is said to have an imperfect metamorphosis.

The parent insect deposits her ova upon an aquatic plant or drops them in the water. The nymph soon hatches, and commences a period of grovelling along the muddy bottom of pond or stream. Its colour is very similar to the surroundings, because, with wonderful chameleon-like ability, it can adapt its hue

to that of mud, stone, twig, or other object it rests upon. It has six long and powerful legs, but upon these it does not wholly depend for progression. The head is large, the body sub-lanceolate in shape. It breathes in a most remarkable manner. At the end of the abdomen are five small leaf-like appendages, which can be separated or closed together at the will of the creature. When these are opened, water is drawn through an orifice into the abdomen. When the air contained in the water has been exhausted, the water is ejected from the orifice with such force that the nymph is propelled forward with great rapidity and for some distance. It can also breathe by means of air-holes or spiracles.

Yet another remarkable feature of the nymph claims attention. It is the method by which it captures food. The lower lip is developed into a double-hinged and folded apparatus, of very singular appearance. The term mask is applied to it because it hides the lower part of the head. The basal end is attached below the mouth; the other end is furnished with a pair of long, sickle-shaped forceps. The purpose of the mask is to seize

the prey, and it does so in a most effective manner. It has no power of mastication, such as the mandibles have. When food is sighted the nymph stealthily creeps towards it, and when within measurable distance the mask is shot out, captures the object, and returns, with a speed too rapid to be seen. The object seized simply vanishes. The folding back of the forceps brings the prey immediately beneath the mouth, and they retain it while it is devoured by the mandibles.

When preparing to assume the aërial state the nymph ceases to feed, ascends the stem of a plant until some distance above the water, and there awaits the final transformation. It clasps the stem firmly with its feet, and moves the body in a peculiar manner until the skin, or puparium, splits for some distance along the dorsal surface. The head and thorax then emerge, the legs are gradually drawn out, and are fastened around the puparium, and at that stage the insect rests for some time. When it has gained strength, and the skin has hardened, the abdomen is withdrawn. The wings, which hitherto were very small and imperfectly formed, now begin

to unfold, and rapidly increase in area. Their expansion is produced by air from the insect's body being forced into the nervures. While, however, that is taking place the membranes are most delicate, and if scratched a green fluid exudes.

When all parts are mature and hardened by sun and air, the insect leaves the resting-place to enjoy the new life. That seldom lasts three months. They die before the approach of autumn. No British dragonfly is known to hibernate.

The breathing of the imago is performed in the same manner as that of other insects, viz., by small holes or spiracles in the sides of the body; eight pairs in the abdomen, and two pairs in the thorax. The legs are six in number, all nearly of the same length. Although long and slender, they are not very well adapted for much walking, for which, indeed, they are seldom required. But they are strong, and can hold firmly to plant stems or other objects upon which their owner alights. If a living dragonfly is held captive by the wings, and an insect presented to it, it will hold the food by the six feet, while

devouring it; and this fact strengthens the belief, that when on the wing the legs are also used as a trap to catch, and retain, the prey—the long spines with which those of most species are clothed making them more effective.

The food of dragonflies consists of spiders, millipedes, centipedes, and all kinds of insects. For the latter it hawks from early morning until the evening, never satisfying its appetite, capturing them on the wing and eating every suitable part. The writer has seen *Æ. grandis* catch a butterfly in flight, carry it to a bough, nip off the wings, which fluttered to the ground, and devour the body.

On another occasion the same species was observed to settle on a hedge. When approached, a large living fly could be seen being held between its mandibles. The dragonfly was so intent on consuming its prey, that the writer got to within two feet, and watched until every part of the fly, except the wings, had been consumed. The dragonfly then cleaned its mouth parts with the forelegs, and flew off to pursue other quarry.

A very prominent feature in every dragon-fly is the enormous size of the head. This is accounted for mainly by the two compound eyes. (There are also three very small, simple eyes.) In fact, the head is all eyes and mouth parts. The compound eyes are masses of lenses in the form of two hemispheres. It has been proved that each lens in the eyes of insects receives and transmits a distinct image of any object to the nerve centre or ganglion in the head. It is stated that there are about 17,500 lenses in each eye of Figs. 1 and 3. The power of viewing objects in every direction must be almost unlimited, and doubtless it is of immense value to the insect in pursuit of prey, and the detection of its own enemies.

VI

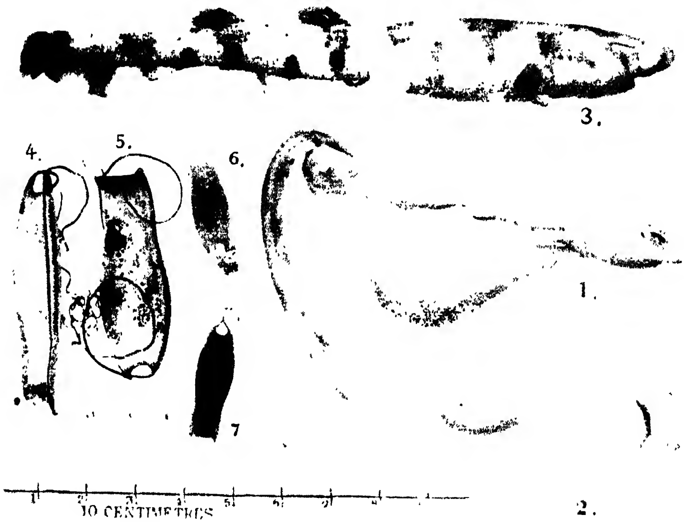
DOG-FISH AND THEIR EGG-CASES

IF it were not for the abundance of marine fishes a very large number of people would sometimes be short of food. And the numerous kinds of fish enable everybody to satisfy their tastes; from the abundant and cheap sprat, herring, and mackerel, to the larger and more costly salmon and sturgeon. The ease with which fish may be caught is another immense advantage. At certain seasons some kinds of fish are so prolific that prodigious numbers are brought to land, too many sometimes to find buyers, and cartloads remain on the beach unsold, to be either carried away for manure, or taken out to sea and thrown overboard.

The largest catch of mackerel on record was made on September 21, 1903, when ten fishing smacks entered Folkestone Harbour,

PLATE No. 6.

SMALL BRITISH SHARKS.



THE GREATER-SPOTTED DOG-FISH.

Squalus canicula.

1. 2. Young fish removed from egg-cases, with yolk-sacs. 3. Older fish with yolk-sac almost absorbed. 4. 5. Their egg-cases. 6. 7. Egg-cases of the Lesser-spotted Dog-fish.

(The fish three-fourths nat. size. The egg-cases three-fifths nat. size.)

with a total of 130,000 mackerel between them. They were sold at an average price of 6*s*. per hundred.[1] About the same time the catches of herrings along the east coasts of England and Scotland were phenomenal for their vast quantities. This wonderful abundance is surprising, yet it should cause no wonderment. Anybody who has seen the hard roe of a fish can easily understand the reason. Every globular fragment of the mass is an ovum from which a fish will develop, and most of them when mature become the parents of a similar mass of ova.

Many thorough and careful experiments have been made by students of marine fishes to ascertain the number of ova produced by various species. 'The method by which this is done is as follows: The whole of the two roes from a fish are carefully weighed, and then a small quantity, say half an ounce, is weighed separately. Then this selected portion is gradually boiled, in order to separate the eggs, and make them more distinct. The number is carefully counted, and the result multiplied by the number of times the

[1] *Daily Express*, September 22, 1903.

weight of the selected portion is contained in the weight of the whole of the two roes.'[1] From the same authority the following figures are taken. The herring will contain 47,000 ova; the sole, 750,000; the cod, 6,652,000; the turbot, 9,161,000. While these figures are almost beyond comprehension, they are small compared with those of the ling. A specimen of that fish, measuring five feet in length, and weighing 54 lbs., contained 28,361,000 ova; each ovum is 1 mm. only in diameter; *i.e.* twenty-five ova side by side in a row would just reach from margin to margin of a halfpenny. The ling is abundant all round the British and Irish coasts. Its principal food is other fish; though the lobster, cuttle-fish, and octopus are also devoured. The fish is edible, but it is not a favourite.

The continuous feeding of every kind of fish upon other fish smaller than itself is one of those strange and immutable laws which appear to be essential in maintaining the balance of Nature. With such immense figures as those just quoted it will be easily

[1] *The Marketable Marine Fishes of the British Islands*, J. T. Cunningham, pp. 68, 69.

recognized that but for some check, and that on a vast scale, the sea would become over-populated with fish.

But all fish do not produce young in such vast hordes; there are some kinds whose progeny are very few in number. No fish, perhaps, produces so few young as do the so-called dog-fish. The reason for this will become apparent in the course of the following remarks.

The dog-fish are members of the same order as the sharks. Five of the nine existing families of sharks are found in British seas, but none of the British species attains so great size as those inhabiting tropical waters. Their commercial value is not great, although the flesh is pleasant to eat. The name of dog-fish is merely that applied to the smaller and commoner kinds of British sharks.

All sharks are remarkable on account of the skeleton containing no true bone. Even the vertebral column has no lime in it, but is formed of an admixture of a glass-like material named hyaline and cartilage in a more or less fibrous condition. The other

portions consist of cartilage or gristle, which is soft and elastic.

In place of the ordinary easily removed scales peculiar to most kinds of fish, the skin is covered with very small plates, spines, or tubercles, known as placoid scales, which, having a large amount of lime in them, are hard and strong. Because of the sharp points of the tubercles the skin is sometimes used by cabinet-makers in place of glass paper for smoothing hard woods.

Dog-fish are strong and active swimmers, usually keeping near the bottom of the sea, and are therefore spoken of as ground-sharks. They feed mostly at night upon small fish, crustaceans, and carrion. Some species are very mischievous in their habits, doing much damage to fishing-nets; but they are comparatively harmless to man, never attacking bathers, as do sharks of tropical seas. They seldom exceed four feet in length. They are social in their habits and usually hunt in packs, hence the reason for the variety of their provincial and local common names, such as spotted dog, penny dog, smooth hound, rough hound, beagle, hound, bounce,

robin huss, etc., most of which have some bearing upon their habits.

The two species most abundant in British waters are the greater-spotted dog-fish and the lesser-spotted dog-fish. The greater has a number of large black spots on its body and fins. The lesser is not only the smaller fish, but its spots are very small, although more numerous.

The body of a dog-fish is cylindrical—thickest at about one-third of the total length from the head, tapering gradually to the tail, but rapidly towards the snout. The eyes are large and bold. The mouth is somewhat in the shape of a crescent, situated not at the extremity of the head, but underneath. The teeth are small, sharp-pointed, and very numerous, and suited for cutting and firmly holding their prey. The tail has a long upper lobe in which the vertebral column is continued.

These fish are destitute of an air-bladder. They are the only fish which produce eggs containing so much yolk that the whole development of the young fish is completed within the egg-case. The materials composing the egg are accumulated within the

ovary. When it has attained a size about equal to that of the yolk of the hen's egg, it leaves the ovary, and while passing along a fleshy tube, which is the oviduct, it becomes coated with a layer of albuminous matter, which is regarded as equivalent to the white of an ordinary egg. At the lower extremity of the oviduct it is enveloped by a peculiar-shaped case.

This case is of extreme interest; there is nothing exactly like it to be found in any other animal. It is composed of a horny substance, the material of which is produced by a special secretive gland. The lower part of the case is formed before the egg reaches it; afterwards the remainder is formed. Then the case and its contents are pushed further down the tube to await extrusion. It is then of an oblong shape, with a very long, slender, solid tendril emanating from each of the four corners. When it is ready for extrusion the lower pair of tendrils are projected from the fish's body, and, in consequence of their fibrillose form and nature, speedily entwine among seaweeds or other marine growths, and act as anchors. The fish, finding them securely

attached, swims around the object, and by this process the case is drawn out of the oviduct. It is then abandoned, and the embryo-fish left to take care of itself. Bunches of twenty and thirty of the cases, held together by their tendrils, are often brought up in the trawl, showing that many of the fishes had frequented the same spot to rid themselves of their ova. One species of dog-fish, the blackmouth by name, produces a case for the egg, but it is without filaments or horn-shaped projections.

The colours of the egg-cases vary from light yellowish brown to very dark brown; some have a greenish tinge. Its substance is tough, fibrous, and flexible, and is quite free from any admixture of lime. When dry it contracts to about one-third its original size, becomes very tough and hard; the tendrils also become very much convoluted and brittle, easily snapping off.

The cases are deposited in the autumn. Development of the young fish is very slow, several months elapsing before it emerges. When it does emerge, it is completely formed, and at once enters upon the same mode of

life as its parents pursued. The egg-case of the greater-spotted dog-fish is rarely seen on the beach, but those of the lesser species may frequently be found. These are about half the size of the former, much paler in colour, and so translucent that if held against a strong light it can at once be determined whether the young fish is within, or has hatched out.

The strength of the tendrils is surprising in comparison with their extreme length and tenuity. Many of them exceed 40 inches in length, and will sustain relatively heavy weights without severance. At the point where they are attached to the case they measure about 2 mm. in diameter, and from that size they gradually taper off to the most slender thread. When in a moist condition they are more or less spirally contorted, and also pliable, and if drawn out, when released recoil with a considerable amount of elasticity.

In the lower left-hand portion of the illustration may be seen two egg-cases of each species of the dog-fish, one-fourth natural size. Their relative proportions are thus easy

of comparison, and will assist the collector in determining the two species. Unfortunately, the tendrils of the larger specimens are much broken and scanty in quantity, but those of the lesser species are very representative of their kind.

These egg-cases have been humorously compared with pillows having long strings at each corner. They are popularly known as mermaid's purses, sailor's purses, sea purses, etc.; more often found in an empty state than otherwise, and then not containing an article of any use or commercial value!

The egg of the dog-fish consists of three parts: the yolk, the white, and the case. The white is a thick transparent liquid. The yolk, which is the essential part, is a yellow semi-liquid substance, enclosed within a thin skin-like material known as the yolk-sac. It retains the yolk in a globular shape. Upon its surface is the germ from which the fish develops. Where the germ is situated the skin becomes thickened into a membrane, which gradually spreads around the yolk; this is the embryo of the fish, and as it increases in size the yolk diminishes. As

the young fish grows, the tail portion curves round the yolk-globe, and is directed towards the head. This explains the curved form of two specimens in the illustration, all of which were purposely removed from egg-cases before attaining maturity. Throughout the whole of the embryonic stage the yolk-sac is connected, by a short tubular prolongation of its investing membrane, to the ventral surface of the young fish, and in direct contact with its stomach. The central specimen exhibits this character to a nicety. It will be observed that the shape of the yolk-sac is pyriform. That is because of the pendent position; in the egg-case it is globular.

As development of the young fish proceeds, the yolk-sac with its contents becomes smaller. No portion of it is separated from the animal; it is simply absorbed, every portion of it contributing towards the nourishment of the embryo.

A medium stage in its absorption is seen in the lower figure, where the fish is viewed ventrally. The shape and position of the mouth can also be seen. In the profile view of the uppermost specimen the yolk-sac has

almost disappeared, only a very small portion remains, and the fish in that condition is nearly ready to leave its egg-case. The large dark marks characteristic of the greater-spotted dog-fish are already in evidence. The whole of the yolk-sac ultimately disappears, and a small umbilical depression alone indicates its former place.

The facilities for the embryonic fish to breathe are simple but effective. Each end of the case is so formed that, although the edges are disunited, they are in sufficiently close contact to prevent anything but water from entering. A continual current of water enters at the end where the head is situated, and passing through the case, issues from the opposite end.

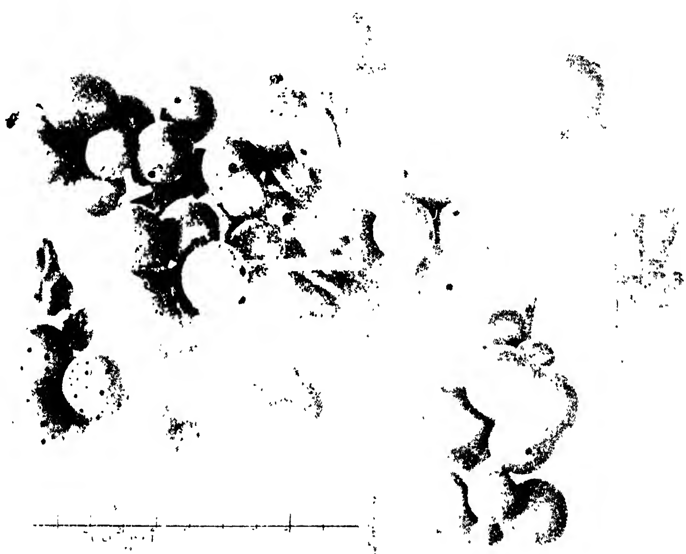
When the fish is ready to emerge, it has merely to push its way between the closed edges. Exit is simplicity itself; entrance is impossible. There is no external change in the appearance of the egg-case after the departure of the fish.

But sharks are not the only oviparous fishes whose eggs are enclosed within horny cases. The egg-cases of skates and rays are

similar in texture, but relatively broader, and with curved pointed projections from each corner, which are hollow throughout their length, are not tendrilous in character, and never more than a few inches in length. Two kinds at least are well known to persons who wander along the beach during the winter months, or search among the flotsam and jetsam left at high-tide mark.

PLATE No. 7.

OAK MARBLE-GALLS.



MAGNIFICENT CLUSTERS OF MARBLE-GALLS ON OAK TWIGS, produced by the Gall-Wasp, *Cynips Kollari*, Hartig

One insect can be seen at the extreme of the left-hand top corner of the illustration, and another further to the right-hand.

Half nat. size

VII

OAK MARBLE-GALLS

AN observer of the hedgerows during autumn, winter, and spring, cannot have failed to notice numbers of small brown globular objects affixed to the twigs and other parts of the leafless branches of oak bushes. Sometimes these little brown balls are seen in great profusion, while at another part of the hedge they are few and far between. They are found to grow singly, and in clusters of four, six, and occasionally twelve and fourteen.

These little balls are frequently spoken of as oak apples, but that is a misnomer. The correct name is oak marble, and very appropriately so, since they are globular in shape, hard and solid in structure, and rather larger than an average stone marble, but not

so heavy. The oak apple is very different in every way. They are in reality an abnormal growth of the tree, a growth that, so to speak, has no right to be there, a growth that is termed a vegetable gall. Now a gall upon a plant, whether some humble wild flower along the wayside, or a noble forest tree, is a kind of disease which manifests itself mostly in an external and somewhat independent form, but, instead of having an unhealthy character or being of no use, it has a distinct function in the economy of Nature. And, again, whereas disease, in the form of galls or warbles, in animals produces pain and illness, the gall on the plant causes no deterioration of its functions, and only in rare cases interferes with its fruitfulness and utility to mankind in arts and commerce.

We have, then, a small spherical vegetable production growing upon the oak, which, although organically connected with the plant, is entirely unlike the fruit and seed of that tree (viz., the acorn), and which is neither bud nor leaf, yet has a purpose to fulfil that is totally distinct from the functions

of the plant, even though it draws all its sustenance from the plant.

A brief outline of the origin, growth, and structure of the oak marble, and the purpose it serves, may be of interest. Its origin is due to the energies of a small four-winged fly, technically named *Cynips Kollari*, and known as a gall-wasp. *Cynips* is the genus which includes a large number of small wasps, nearly all of which produce galls. V. Kollar is the name of a celebrated Continental naturalist, who first noticed this insect. The body of this gall-wasp is most brilliantly coloured with bright metallic yellow, orange, and purple, the resplendence of which is observable at greatest advantage when viewed in the sunlight, and with the aid of a pocket lens. There is little veination of the wings, but it is exceedingly delicate, and owing to being covered with minute hairlets, the iridescence is of a kaleidoscopic nature. The length of the insect from the front of the head to the end of the body is about 4 mm. (25 mm. = 1 inch, see scale on page 13), and about 11 mm. from tip to tip of the wings when extended, as in flight.

In the month of October the parent insect seeks a twig of an oak, and after piercing a hole with her ovipositor near where the leaf is attached, she deposits an ovum in the hole, and goes her way, to repeat the process. She is capable of depositing about eight hundred ova, but investigations of the habits of the insect have shown that very seldom as many as one-sixteenth of the number are actually deposited. The vegetable cells at once begin to accumulate around the egg. At the same time the development of the embyro is proceeding rapidly, and the larva shortly emerges from the egg-shell, to find itself enclosed within the tissues of the plant. But the swelling on the surface of the twig is very small, and cannot be detected by the ordinary observer.

During the remainder of the autumn and throughout the winter months little, if any, change takes place. Both plant and larva are dormant. In April, however, both are aroused to activity, and in May the swelling is easily observed. By the end of June it will have attained the size of an ordinary pea, and be of an emerald green colour; it

is also somewhat soft and pappy. During the following month it grows rapidly, and a thin outer skin, or epidermis, falls off; it then assumes a more brilliant green, almost a golden-green colour. At this period its structure consists of eight different parts, several of which are nutritive tissues, albuminoids, oil globules, resin and starch, some of which are used up, and not replaced.

In August the size increases, the texture becomes firmer, and the colour a deeper shade of green. Meanwhile the larva within has steadily increased in size, obtaining its entire sustenance from the central portion of the structure. Towards the end of September the gall becomes more solid and harder, the green colour gives place to brown, and no further alteration in either size or colour takes place. It is now a mature gall, and twelve months have been necessary for its development. During the greater part of the time galls have not been easily observed, having been shielded from view by the foliage. The rough winds, and the inevitable decay of plant life characteristic of late autumn, soon reveal the bare boughs,

and then the marbles are distinctly visible. They are not, however, similarly affected. No amount of wind, rain, hail, or frost will dislodge them. They will maintain their position for two or three years, unless disturbed by man, the decay of their own substance, or the growth of new wood.

But what purpose do these galls serve? Their growth is solely for the benefit of the larva. The accumulation of the vegetable cells has a twofold purpose — one, the primary, to provide suitable food for the larva; the other, to afford it a shelter from adverse atmospheric changes, and also a protection from parasitical enemies. The enormous thickness of tissue surrounding the larva does not, however, always form a complete protection; some parasites are able to accomplish the destruction of the rightful owner, but only during the earliest stages of the growth of the gall.

The larva is very fat, creamy white in colour, and glossy, devoid of eyes and legs, and is about the same size as a hemp seed. Its mouth is at the top of its head, and it is provided with a pair of sharp and strong

jaws. Respiration is effected by means of airholes, or spiracles, in the sides of the body, the air passing through the substance of the gall. The larva turns into a chrysalis within the gall, and ultimately eats its way out, emerging in the form of its parent.

Two of these insects can be seen on the galls shown in the photograph reproduced, one at the extreme of the left-hand top corner, the other further to the right hand. In the lower left-hand corner it will be noticed that each gall in the cluster of three has a number of very small holes in it; many of the other galls have only one hole, circular in outline, and large enough to admit an ordinary match-stick. There are also, just above the centimetre scale, two galls smaller than any of the others. Their diminutive growth is due to the fact that while in an early stage they were attacked by a parasite, the offspring of which devoured the *Cynips* larva, and thus caused an arrest of development. But it will be noticed that the galls of the former cluster are of normal size, although perforated with many small holes. They have been inhabited by inquilines. Now, a parasite feeds upon

and eventually destroys its host. An inquiline, however, does not molest the host, but only feeds upon the vegetable cells which surround it, and does little or no harm to the structure.

The centre stem in the above illustration bears thirty-eight galls. It may be regarded as a very fine example, consisting of an unusually large accumulation of galls on one stem.

Instances are often to be found where two galls have completely coalesced, but three in such a condition as seen in the cluster on the right hand are far from common; that particular specimen is also extra large.

The solitary gall upon the slender twig exemplifies the large size to which some attain. It is 3 cm. in diameter, twice that of most specimens (see scale on p. 13). The length of the twig also is remarkable. The writer has one 32 cm. long, with only one gall at the end.

When food is scarce, birds and small rodents (voles, etc.) gnaw into the galls to get the larva, which is indeed a juicy *bonne bouche.*

Viewed from a utilitarian point of view, these galls are of little service. Attempts have been made to use them in the manufacture of ink; but, owing to the very small amount of tannic acid they contain (somewhere about 17 per cent.), as compared with its congener, the Aleppo oak marble, their use has long since been discontinued. As a natural curiosity it is of interest, and more lasting in its beauty than any other of the sixty different kinds of galls on the British oak. Sometimes they are used in making little ornamental baskets and similar fancy articles.

It appears that although well known on the Continent for a great many years, the gall was not observed in England until the year 1834. Twenty years later it was reported as being abundant in the south-western counties, and it was named the Devonshire gall. Now it may be found in any part of England and Scotland.

VIII

THE CREEPER-TUBE AND ITS MAKER

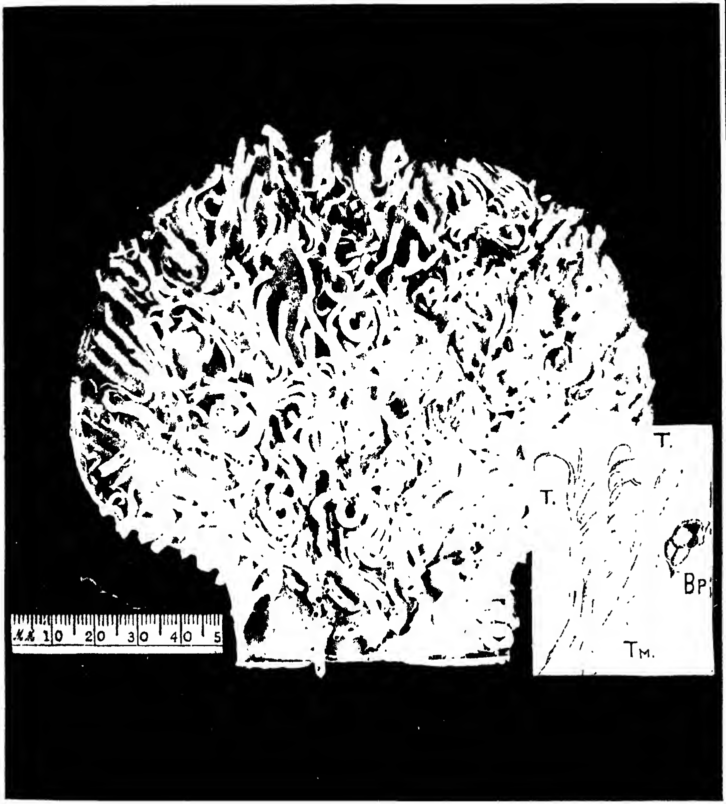
AMONG the numerous forms of protectionary coverings produced by marine animals, the cases and tubes inhabited by worms possess great interest, even although they are somewhat deficient in brilliant coloration.

In the great phylum of Crustacea there is an external skeleton—a material composed of several substances, the greater proportion (60 per cent.) of which is carbonate of lime.

Of this material there is an enormous amount held in solution in sea water, and a great army of animals have the power to abstract and consolidate it into shells, as do the Mollusca; tubes, as Annelids; internal deposits, as Coral polyps; external deposits,

PLATE No. 8.

WORM CREEPER-TUBES.



TUBES OF *SERPULA ARMATA*, Fleming, ENCRUSTING A SCALLOP VALVE

Also diagrammatic figure, × 4 (after Claparède) of the animal of an allied form. TM. Thoracic membrane. BP. Brood pouch. T. Tentacles.

(Tubes two thirds nat. size.)

as Corallines; and external coverings, as crabs and lobsters.

The colours of many kinds of shells and crabs and corals are extremely varied and beautiful.

The creatures now to be considered by us are known as tube-worms. They are included in the phylum or division of the animal kingdom known as Annelida, which includes all worms. The Annelida are so called because their bodies are divided into rings or segments, and in that particular these animals differ from the Mollusca (snails, oysters, and the like), although they produce and live in a shell-like tube.

The skin of worms is composed very largely of muscular tissue, and the body can therefore be greatly elongated or much contracted. The body contains a nervous system, a circulating water system, and the usual complement of internal organs. The surface of the skin is thickly studded with stiff spines of many shapes and patterns, some being very curious and beautiful. These spines are of a hornlike nature, and are termed in scientific words chitinous setæ. They are imbedded

in and secreted by the skin, and they are of the utmost value to the animals in enabling them to move, and also to adhere to their coverings.

Of all terrestrial annelids the earth-worm is the most widely known. It does not secrete a covering, but lives and burrows in earth without any kind of protection. The majority of the Annelida do, however, construct a cover for their soft bodies, which serves them as a retreat from danger, and protection against being swept about by adverse currents of the ocean. Some cover themselves with tubes which look like long thin pieces of grey rubber tubing; others adorn their tube with fragments of shells and small stones, so that it has been known to attain a length exceeding 60 cm. Several species use grains of sand only; and, while one will produce a long, almost straight, trumpet-shaped tube, composed of a single layer of sand granules placed edge to edge with marvellous precision, another will make its tube much thicker, more uniform in its bore, and in compact masses of dozens, all more or less adherent and parallel with each other.

Sociality is a great feature in many species of this Phylum, and it is exhibited in a remarkable degree in one species (*Filograna implexa*), in which thousands of very small tubes unitedly compose large masses, growing in much confusion of form.

The variety of objects to which these animals attach their tubes is very great. Almost any and every marine substance is affected, from the firmest rock and the seaweeds that grow upon it, to animals of the most rapid movements. Large stones and shells are sometimes thickly encrusted. Many years ago some of the rocks around a little island named Goree, situated south of Cape Verde, on the West Coast of Africa, were (and, perhaps, yet are) covered with a crust of the tubes of annelids several inches thick, and spreading over areas as much as twenty feet square. Anywhere on the British coasts that these animals are exempt from disturbance, they form beyond low-tide mark considerable accumulations. Often after a rough sea small clusters of the tubes may be seen upon the beach. The shells of dead whelks are often almost covered with them,

oyster valves and other shells are also affected. A floating bottle, during a desultory voyage, will become thickly coated.

The favourite shell, however, appears to be that of the scallop, and more particularly the valve known in conchology as the right valve, but in popular terms the convex or spoon-bowl—the part often used for culinary purposes as a scoop. Specimens of these are not only to be found in shallow places of seldom frequented rocks, but are often brought up in the trawl, from the bed of the Channel, and of such origin was that depicted in the illustration. The correct measurements of the valve there shown are; $13\frac{1}{2}$ cm. broad, $11\frac{1}{2}$ cm. high, and the surface presented has 276 tubes upon it; while the reverse side also bears a large number. The scale is 50 mm. = 5 cm. Although the tubes are not so numerous nor so thickly massed together as on some other valves, nor are they so white as they might be, this specimen has been selected from others in the writer's collection of marine annelid tubes, as illustrating all the principal features worthy of examination.

We will firstly notice the name of the animal, and then consider the composition and conformity of the tubes, and subsequently review the animal with regard to its form and its functions.

The classical name of the animal is *Serpula armata.* There does not appear to be any recognized English popular name for it other than 'one of the tube worms.' *Serpula* (from *serpo*, I creep) indicates the plan (or absence of plan) upon which the tube is formed, the procumbent condition, and the various directions the animal takes during the course of building.

The tube is composed of mucine, hardened with calcareous matter secreted in the manner usual with shell-producing animals. In the earliest condition the tube is extremely small, appearing on substances like a very tiny fragment of delicate white silk. Growth is more or less rapid, according to food supply. When mature, it will be about 5 cm. long. There is only one aperture, which is at the last-formed portion of the tube. The tube adheres very firmly to its object of attachment, and where it has an uninterrupted

space will remain so, and also maintain a moderately straight course; but where numbers are congregated (as seen in the illustration), it continually turns aside, becomes much twisted, and curiously interwoven with others around it. It will often rise to a perpendicular position either isolated or attached to others. It is never spiral in form, nor ever has any regular number of coils. The enlargement of the tube is very gradual, increasing in diameter as the animal grows in bulk.

The mouth or aperture of a mature tube of this species is never more than 3 mm. in diameter. The tube is always pure white within and without; any discoloration is external and due to extraneous substances settling upon the tube, and not to colouring matter incorporated by the animal, as in the case of molluscan coverings. The upper part of the aperture is prolonged into a style which projects some distance; and it is due to this growth that the apertures of some of the tubes appear to be double, and that the solitary tube at the bottom of the illustration terminates in a point. One surface of the

tube (when procumbent, the upper) is elevated into a ridge which is much frilled. It is present on the tube from the commencement of its growth, and it terminates in the style just mentioned.

If a cluster of these tubes be obtained while the animals within are alive, and placed in a glass vessel filled with clear sea water, a very charming sight may be witnessed by whoever will spend a little time in observation. When first placed in the water the animals remain quiet for some time, but the exigencies of food supply and breathing ultimately compel them to emerge from the tubes. This is, however, done in a very leisurely manner, and if alarmed by movement of the water or vessel withdrawal is instantaneous. These movements are accomplished by two sets of the numerous setæ, those which produce the protrusive movement not being used during the reverse action. One observer of these animals counted nineteen hundred setæ on the body of a serpula. The movements of the setæ are controlled by muscles of extreme delicacy; yet, so great is their power of resistance that while the

animal is alive it cannot be removed entirely from its tube.

The animal is much shorter than the habitable part of its tube, and it can withdraw to a considerable distance from the aperture.

As a photo-micrograph of a serpula in a living expanded condition is not available, a copy of a drawing of an allied form, *Spirorbis lævis*, is given in the parallelogram of the illustration; but a species whose body is curved instead of straight, as is that of *S. armata*. Little notice need be taken of the internal organs. The parts of greatest interest at present are those marked TT, BP, and TM, since these are the portions which when protruded from the aperture of the tube and expanded, excite the admiration of the beholder, and command the attention of the student.

The Tentacles, TT, are elegant scarlet-coloured, comb-like filaments arranged in rows. 'Examined under a low microscopic power, they present a most charming spectacle. Each filament consists of a pellucid cartilaginous stem, from one side of which

springs a double row of secondary filaments like the teeth of a comb. Within both stem and filaments the red blood may be seen with beautiful distinctness, driven along the artery, and back by the vein (which are placed close side by side) in ceaseless course.

'The exterior of these organs is set with strong cilia, so arranged that the water-current is vigorously driven upward along one side of the filament and downward along the other. Yet the combined result of all the branchial currents is to bring a powerful vortex into the enclosed funnel, the bottom of which terminates in the mouth. The food which sustains nutrition is thus brought to be swallowed, a large quantity of water being at the same time constantly poured into the body. This is discharged in the form of a strong current from the end of the body, which impinging against the closed end of the tube is turned back, carrying all extraneous matter away.' [1]

In addition to these brilliant gill filaments there are two horny threads arising from among them, very different in form and

[1] *Common Objects of the Sea Shore*, Rev. J. G. Wood, p. 98.

purpose but the same in colour. One is very short, and ends in a head like that of a pin. The other is nearly the same length as the gills. When the animal withdraws into its tube, the gill-filaments curl together, but the threads remain straight. The distal end of the longest is expanded into a broad trumpet-shaped knob, and to it is assigned the duty of closing the aperture of the tube to the exclusion of uninvited visitors. At certain seasons of the year it is also modified to perform the function of a receptacle for the embryos. It then becomes the brood-pouch, and in that condition it is shown at BP. It is believed that the smaller thread possesses the latent power of developing into a stopper and brood-pouch, should the other be in any way rendered unfit; because, in captivity, the animals have been observed to throw off the conical club and quickly renew it.

The timidity of these annelids is very remarkable. Although no organ or organs have been discovered which apparently in any degree possess the power of sight, the animals are intensely sensitive to the action

of light, and to the movements of objects near them. If, when fully expanded in sea-water, the hand is moved quickly near the vessel, or if placed in a strong light and a shadow suddenly cast upon them, the gill-filaments are coiled together and retracted within the thoracic membrane, TM, and disappear within the tube with a rapidity too swift for the human eye to follow. Continuous disturbances will to some degree inure them against fright, but they instinctively retreat if alarmed after a prolonged rest. As far as the action of light is concerned in producing the retreat, this animal shares the highly sensitive nature of skin common to almost all annelids. The retreat caused by a shadow may possibly be an inherited trait caused by fear of being devoured.

There are several other species of tube-inhabiting serpulæ, all of which are most interesting to watch or study.

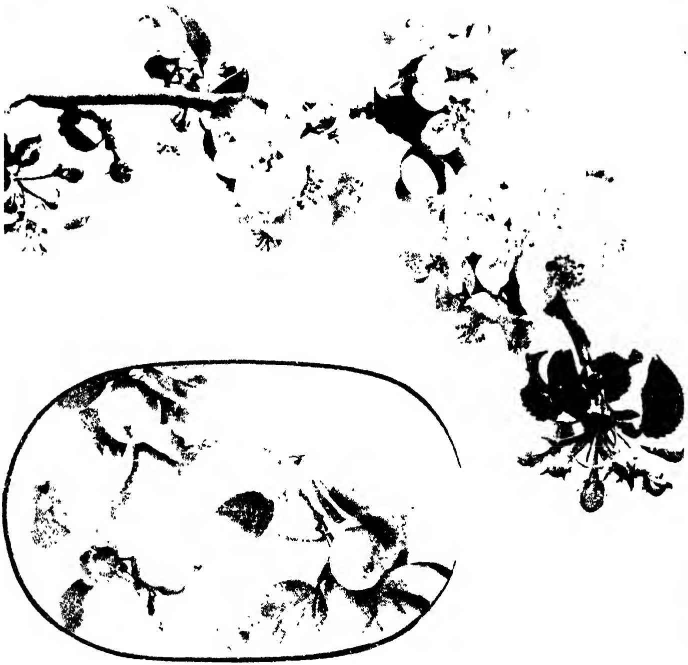
The Rev. J. G. Wood makes the following remarks: 'If serpulæ are kept in an aquarium, they should be closely watched, as they have a bad habit of dying when they are not suspected, and so tainting the water, to

the destruction of animal life. Most of the tubicolous worms come out of their houses before they die, but the serpula often retreats into its tube as far as it can, and there dies. It is very difficult to discover whether the animal is really dead or only sulky—if the latter, it recovers its temper in a day or so, and waves its plumes as usual; but if the former, a white film begins to collect over the mouth of the tube: this must be accepted as a hint for instant removal. In general, if a serpula does not spread its fans boldly and decidedly from the tube, and permits the stopper to droop . . . it is in a bad state of health,'[1] and it should be removed rather than allowed to die, and by so doing taint the water, to the destruction of other creatures around it.

[1] *Common Objects of the Seashore*, p. 98.

PLATE No. 9.

CRAB-APPLES.



BLOSSOMS AND FRUIT OF CRAB-APPLE.

Pyrus malus, Linn.

(*Blossoms half nat. size. Apples one-fourth nat. size.*)

IX

CRAB-APPLE BLOSSOMS AND FRUIT

ONE of the most charming things seen during a walk in many parts of rural England during the latter part of the month of April, and during the whole of May, is the wealth of blossoms on apple, pear, and cherry trees. It would be difficult to find a more charming picture of rural beauty than an old thatched cottage near the roadside embowered in a profusion of fruit-trees arrayed in a manner which, in the judgment of some persons, is superior to their later glory, when the boughs are weighed down with golden ripe fruit, the colour of which is rendered the more rich by the brightness of a midday September sun.

The lovely soft pink tinge on apple and pear petals is perhaps more enchanting than

the almost white petals of the cherry, yet there is a wonderful charm and beauty in the ropes upon ropes of cherry blooms. Unless the observer is certain from previous knowledge, or an examination of the trees be possible, it is somewhat difficult to discriminate between the blossoms of the apple and the pear, and this similarity is the more pronounced when the trees are growing in a wild or poorly cultivated state. The apple tree, however, never grows to the height of the pear tree, and it assumes a more spreading shape instead.

A large cherry tree in full blossom, growing in a state of unrestricted nature, is among the most delightful sights of the landscape and park. But wild, or crab-apple trees, dotted about among the delicate tints of other spring foliage, are visions of loveliness. If this rural simplicity is so highly pleasing, what shall be said of the glorious wealth of bloom of a Kentish, Herefordshire, or Devonshire orchard, with its cultivated and carefully tended trees trained to yield the golden fruit to the fullest extent?

The transient nature of many spring

blooms causes us to appreciate them the more. None more so than those of the apple. The buds are very tardy in expanding during the dull days and sometimes chilly winds of April. Jack Frost, too, is a nightly visitant. The blossoms are extremely sensitive to cold. But part way through May the caressing influence of sunshine, which daily becomes more importunate, compels the buds to yield to the sun's entreaties, and they fling open their petals, thrust out their delicate, filamentous stamens, beseeching insects, all and sundry, to taste of their sweetness. The month of May, however, is apt to be fickle; rough winds, rain storms, sharp nocturnal frosts sometimes arrive with unexpected violence and haste, and cause a vision of ravishing beauty to depart more suddenly than it appeared.

The visits of some species of insects are always of a beneficial nature to the blossoms. Bees notably are the great benefactors. There are other insects whose visits are distinctly opposed to the interests of man. Nearly eighty different winged creatures prey upon the apple tree—roots, wood, leaves,

blossoms, and fruit. The larvæ of moths are the greatest destroyers, and of these there are more than fifty species detrimental to every part of the tree except the roots. Of all destructive agents none are more virulent and to be more dreaded than the very injurious 'American blight.'

As the cause of this infestation may not be known to every reader, it should be mentioned that it is due to the attack of a small insect, whose life history is extremely interesting, but too lengthy to detail. The insect is known as the woolly apple aphis. The term 'American blight' has arisen from the supposition (for which there seems to be a good foundation) that it was imported from America about the year 1787. It is one of several species of aphides, or plant-lice, which attack the apple. The insect is marvellously prolific, and, unfortunately, is equally as destructive in each of the three stages of its existence. It pierces the bark with a long sucking tube, named the rostrum, through which the plant juices are drawn. These punctures result in swollen growths, caused by the effort of the tree to repair the injury,

the interstices of the scabrous swellings providing abundant refuge for the insects.

The injury caused by the larvæ of the codlin moth is very great, its insidiousness also adds to its power of destruction. The larvæ feed upon the core of the young apple, rendering it unfit for food; and being entirely concealed from view, the injury is unsuspected until too late to save the fruit. The larvæ of the lackey moth cause great injury to the foliage. The eggs, which number about two hundred, are laid on a twig in a ring-like band. When the larvæ hatch they spin a web. Within this they all shelter at night, or in wet weather; at other times they wander from it to feed on the leaves. The habits of another apple-tree pest, the small ermine moth, are similar. The mussel scale is another insect whose injuries to the bark by numerous punctures are as detrimental to the welfare of the tree as that of the woolly aphis.

Several species of fungus do much damage to the woody parts of the tree, the worst and most widely distributed being that known as canker. It is a parasitic fungus, and gains

an entrance to the inner part of stem or branch through a crack in the bark. Its growth is slow, but the destruction it does is very sure. A little beetle, by name the apple-blossom weevil, is a regular and most mischievous visitant. The female makes a small hole in the unopened flower buds and deposits only one ovum in each bud. The larva feeds upon the contents of the bud, the exterior of which turns brown and dies; consequently no fruit results. The larva pupates in the same place, and within a month from the time the ovum was laid a perfect weevil emerges.

The apples which grow in a wild and uncultivated state are termed crabs. The apple tree has been cultivated in this country ever since Roman occupation, but most of the best varieties were supposed by Sir H. Davy to have been introduced into Britain by a fruiterer of Henry the Eighth.

The botanical name of the crab apple is *Pyrus malus*, *Pyrus* being the name of a large genus of allied fruit trees, and *malus* that of the apple tree itself. The crab apple has two varieties: one known as *acerbe*, or sour, which

is the true species, and the other *mitis*, or mild; and this species is the ancestor of all cultivated forms, of which it is calculated there are not fewer than two thousand, about four hundred and thirty of which are suitable for the manufacture of cider. One variety, named *Pyrus cordata*, said to be found only in Cornwall, is a curious form, with very small fruit.

The cultivated apple is one of the most serviceable of fruits to mankind. A good, ripe, raw apple is very easily assimilated by almost everybody, the whole process of its digestion being completed within an hour and a half. It is nourishing, sustaining, and health-giving.

With regard to the chemical composition of the apple, it is interesting to note that it contains a larger percentage of phosphorus than any other fruit or vegetable. The phosphorus is admirably adapted for renewing the essential nervous matter of the brain and spinal cord. Other component parts of the apple are chlorophyll, albumen, sugar, lime, gum, gallic acid, and malic acid, also a large amount of vegetable fibre and water. The

acids, as well as the phosphorus, are most beneficial for persons of sedentary habits.

The apple is represented as the food of the gods of the old Scandinavians, and their traditions say that when age and infirmities came upon the people they resorted to this fruit for rejuvenation of body and mind. The English custom of eating apple-sauce with rich foods, such as goose and roast pork, is thought to have originated from the known neutralizing effects some of the component parts of the apple possess. It is also a fact that the fresh fruit eaten ripe and without sugar diminishes acidity in the stomach, rather than provokes it, because the vegetable salts and juices are converted into alkaline carbonates.

There is no other fruit which has so many old legends associated with it, or so much mystical history connected with it in every age and country. It is mentioned in the Bible, in folk-lore, heathen mythology, the classics, Arabian tales, Norse stories, and some recipes in the old British pharmacopœia.

For many ages past certain varieties of the apple have been cultivated for their

properties of producing an abundance of juice, which, correctly treated, forms a most wholesome and pleasing beverage, known as cider. The word cider is derived from the Greek, *sikera*, meaning strong drink. It was at one time applied to any fermented and intoxicating liquor, except that made from the juice of the grape.

In olden times cider, and also perry (the juice of the pear), were the natural drink in a great many localities in England, and other European countries also; but it was not until the end of the seventeenth century that cider was made in large quantities, and of superior quality. It was then the household family drink, varied with home-made wines. A weaker cider, made by addition of water to the second pressing of the pulp, was allowed farm hands in unlimited quantities. It was wholesome and non-intoxicating.

The process of extracting the juice from the fruit was, until comparatively recent years, of a very primitive character. At first the fruit was crushed in troughs of wood or stone with wooden beaters like pestles. Then followed a mill with wheels and trough of

wood; stone wheels were next used with the trough of the same material, and so arranged that they could be worked with one horse. These patterns were superseded by a mill made of iron, and worked by one man, while another fed it. This pattern did the work much better, and crushed about eight bushels of apples an hour. Various other kinds of mills have been introduced, but those in which the trough and rollers are of stone crush the fruit best, and yield the most satisfactory results. The crushing power must be even, and the revolutions of the rollers or wheel not too rapid, to obtain good cider. The fruit, too, must be sufficiently ripe, but not over-ripe, and free from bruises. It is usually shaken from the tree on to a layer of straw, unless grass is abundant. The apples are then placed in heaps until mellow for the mill. These heaps are formed in the orchard itself, from twelve to twenty-four inches thick, and protected from rain, sun, and other climatic changes, or else in a shed or well-ventilated outhouse.

There is a certain degree of fineness to which the fruit should be reduced to pulp,

and, while the flavour of the juice of some varieties is improved by the pips being crushed, so that the essential oil they contain may blend with the juice, other varieties of apples should not have the seeds crushed. The pulp, or pomage, is removed from the mill and put into large open wooden vats. They are lightly covered with a cloth or board and remain untouched for several days. During that time gentle fermentation takes place, and the juice and the alcohol formed from it are enabled to extract from the peel and solid portions of the fruit the full flavour and perfume, which are so necessary to give a high character to the cider.

When a sufficient time has elapsed, the pomage is taken to the mill, where it is subjected to heavy pressure between rough horse-hair cloths, or layers of clean straw or reeds, the juice exuding in the form of a thick brown fluid known as 'must.' The must is run into large casks, which are placed in a cool place, for the sediment to fall and the most active stage of fermentation to take place. When fermentation is complete, the clear liquor is drawn off by means of a glass

syphon tube into barrels, a little dissolved isinglass added, and the bung closed. The cider will be ready for use the following April.

The solid portion remaining in the pressing bags is sometimes re-ground in the mill, with the addition of commoner varieties of apples, and a considerable quantity of water. An inferior juice is the result, suitable only for immediate consumption. In all the process for converting the juice of the apple and pear into cider and perry, from beginning to end, the most scrupulous cleanliness is necessary. The mill should be thoroughly scrubbed before use. The barrels and casks must be perfectly clean and sweet.

A spirit is distilled from cider, which varies in flavour and strength according to the richness of the must, and the care with which it has been made. It is sold as orchard-brandy or apple-brandy.

Perry is more difficult to make than cider, and is consequently little used.

PLATE No. 10.

THE COMMON SEA-MAT.

A LARGE AND FINELY-PROPORTIONED TUFT OF THE BROAD-LEAVED HORNWRACK.

Flustra foliacea, Linn.

Also a photo-micrograph, × 40, of a fragment.

(Half nat. size.)

X

THE COMMON SEA-MAT, OR HORNWRACK

FEW objects to be seen upon the beach at high-tide mark are so frequently examined by those who ramble along the seashore as that which is depicted in Plate 10.

The broad-leaved hornwrack, sea-mat, or *Flustra foliacea*, may be found more or less all the year round, but with greater frequency and more abundantly from October to May than during the other months. February and March are the principal months, and during them it can always be seen left by the ebbing tide. Some seasons it is extremely abundant. In the year 1903 the beach at Hastings, from the Fishmarket on the east to Bulverhythe on the west, was for several days strewn along the high-water mark with

a fringe of this remarkable substance, varying in width from fifteen or twenty inches to several feet. It was somewhat intermittent, as might be expected, considering it extended for more than four miles, but it was nevertheless noteworthy. On February 15, 1905, the writer saw a similar sight on Camber Sands, near Rye, Sussex, and fortunately having his camera with him, secured a representation of it. It there formed a continuous belt, which at several parts was more than twelve feet wide and six to eight inches deep, extending without the slightest interruption for more than half a mile. When occurring in such profusion, the odour from it can be detected some distance away. This seashore of South-east England is not an isolated one as regards this phenomenon; it may be seen in other parts of the coast also.

Such interesting sights arouse within the mind of the thoughtful observer a two-fold inquiry: From whence comes the material, and, what is its nature? We will endeavour to explain.

First, then, from whence comes the material?

During the first three months of the year the fishermen do a great deal of trawling, or dredging, as it is variously named. A trawl is a specially constructed, triangular-shaped net fastened to a framework of wood and iron. It is attached to a long, stout rope, the other end of which is made secure to the fishing-boat. When the trawl is put overboard it sinks, and, as the boat goes along, the trawl is drawn over the floor of the sea, where it gathers various objects within it. After a while it is hauled up, and its contents emptied into the boat. All that is of a saleable nature, such as whelks, scallops, crabs, fish, etc., are put aside, and the remainder thrown into the sea. Sometimes the trawl contains great quantities of the Flustra, which has been detached from stones and rocks upon which it was growing. The Flustra does not again become affixed to any object, but floats about in the sea, being gradually drifted towards the shore, where it is ultimately cast by the waves and left stranded in the manner previously described.

But the second part of the inquiry must not be so summarily treated. Indeed, it is

far too interesting. The more closely the Flustra is examined, the more wonderful is its nature and composition found to be. Lying upon the beach, it seems scarcely worth more than a passing notice. When investigated by the aid of a pocket lens or microscope, there is revealed a most wonderful and beautiful arrangement of minute life.

The name of *Flustra foliacea* was bestowed upon it by the great Swedish naturalist, Linnæus. The word *Flustra* is derived from *flustrian* (Saxon), to weave. The genus Flustra embraces five species, two of which, *foliacea* and *papyracea*, are depicted in our illustration, the latter being represented by the delicate filaments in the centre of the lower half. It was growing in that position when found—a rather unusual circumstance. But it is *foliacea* species we are now investigating. When freshly taken from the sea it has a decided perfume, which affects different people in different ways. To some the odour resembles that of the violet, to others it is like verbena, while the peculiarity of the geranium is recognized by others. After a

time the odour becomes less pleasant, and after being washed in fresh water and dried very little smell is noticeable. It may be found in many seas of the world, but it is most abundant and most widely represented in the northern part of Europe, and especially around our own coasts.

It grows attached to various objects, such as rocks, stones, and shells, in an erect and foliaceous or dendritic manner. It seldom attains a greater height than 20 cm. (*i.e.* 8 inches). The 10 cm. scale has been placed in the illustration to enable the reader to appreciate the dimensions of the specimen. The writer picked up the specimen from the beach at St. Leonards. It is all one piece, and typically representative of the species.

Flustra foliacea varies considerably in its manner of development. Although the fronds are always flexible, horny in character, and of uniform thickness throughout their entire length and breadth, in some specimens they are very broad, others very narrow; in some the segments are short and numerous, in others they are very long; again, they may

rise from the base moderately wide, and remain so throughout their entire length, while others, narrow at the base, widen as they rise, terminating in a broad truncated extremity. It does not grow between tide marks, consequently it is never found in its original condition on rocks exposed at low tide. In the deeper parts of the Channel its growth must be of the most profuse nature possible.

Its appearance is very much that of a seaweed, although its colour is very different from that of seaweeds generally. But it should be noted that when dry the surfaces have a glossy appearance, as though a thin film of varnish had been spread over them. No seaweed when dry has that.

It does not make any difference whether there are few or many fronds in a bunch, the beginning of the growth is the same. Briefly, it is in the following manner: A minute speck of life, enclosed within a tiny blob of jelly-like substance, is swimming about in the sea by means of numerous microscopic hairlets upon it. After a while it settles upon a stone or shell and becomes attached. Changes

in its form and functions at once take place, and from that solitary individual there rapidly develops a colony of small polyp-like organisms, so numerous that figures in the millions are necessary to represent their totals.

Each individual surrounds itself with a covering of corneous material, which is the exoskeleton forming a cell or a zoœcium. It does not, however, cover the cells of any other individuals, but places itself either by the side or on the top of its neighbour. They also arrange themselves back to back; therefore both sides of a frond are alike. When numbers have formed themselves into a frond, the word 'zoarium' is the term applied to the whole colony. The building up of the colony is by a process known in science as budding, each bud developing into a perfect creature, but retained in organic connection with all those around it. If a finger be passed over a frond of *Flustra* from its base to extremity, a peculiar velvety feeling may be noticed; but when drawn in the opposite direction there is a very perceptible roughness. The reason for that is indicated within

the white circle in the illustration. The area there enclosed is a photo-micrograph of a small portion of a frond. It will be seen that a frond is composed of vast numbers of cells or zoœcia, which in shape are broad and rounded above, narrow and truncated below, overlapping each other to a certain extent. Each cell (with some exceptions) has four short spines projecting from it. These spines are the cause of the rough sensation to the finger. They are probably for a defensive purpose. There is also a little hinged plate which closes the only external opening of the cell. When the creatures are at rest they are entirely concealed, but when desirous of feeding they push themselves out, opening the little lid, and expand a bell-shaped coronet of ten filiform tentacles of extreme tenuity and marvellous beauty of coloration. These are waved about for the purpose of capturing minute organisms in the water which constitute their food. The cells number about 150 in a square cm. (370 in a square inch).

Upon a further reference to the circular illustration, two zoœcia can be seen rather

smaller than those around them. Moreover they are devoid of spines; and could we see the portion in the profile, it would be noticed that they project beyond the others. Such peculiar zoœcia are scattered all over the fronds. They are termed 'avicularia,' but their use and purpose does not appear to be fully understood. In *Flustra* they are of a rudimentary nature, but in some other Polyzoa (*Bugula*) they are very highly developed, and resemble a bird's head, the upper mandible being hooked, the lower one spiked, both portions being controlled by strong muscles. A remarkable feature in the construction of each zoœcium is that there are minute perforations in the sides, and through them threadlike portions of the nervous tissue pass and connect all the polyps with one another.

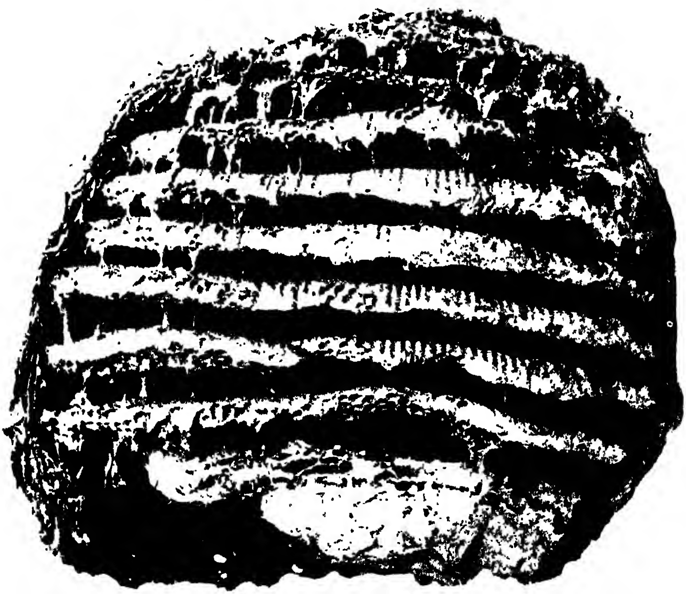
If a piece of living frond is placed in a shallow dish containing sea water, and examined with the aid of a lens, here and there a bundle of tentacles may be observed slowly emerging and expanding into the bell-shaped coronet. On the least disturbance of the water or movement of the dish, the tentacles

are rapidly withdrawn into the zoœcium and the lid shut.

To see these dainty little creatures actively engaged in securing their food is a sight worthy of anybody's attention.

PLATE No. 11.

SOCIAL WASPS.



A LARGE VESPIARY OF *VESPA GERMANICA*, Linn.

The number of wasps produced in this vespiary from June to November, 1901 (both months inclusive), was 44,500.

(*One-fourth nat. size.*)

XI

A BRITISH SOCIAL WASP

WASPS are of two kinds, solitary and social. The solitary wasp lives by itself, and although it makes very few cells, sometimes not more than one, it does not share them with other wasps. The social wasps are quite the reverse. They live together in communities numbering hundreds, and sometimes thousands, of individuals; they are wholly commensal in their habits, and their economics are most interesting. The solitary wasps are never so numerous as the social wasps; they are not so pugnacious, nor do they, except on rare occasions, invade houses in search of food. Their life history is nevertheless worthy of attention.

To fully describe the anatomy of a social wasp, and the construction of the habitations

made by six of the British species, would open out too wide a range of study for the present purpose. Your attention is therefore invited to a brief consideration of the insect, and its mode of life.

Possibly no other insect in England is the cause of so much dread as a wasp. Almost everybody has a feeling of dislike towards a wasp, and is anxious to destroy it, or to get out of its way. But a battle with a wasp is not always attended with victory on our side. Wasps are quick, very quick, and carry a small but powerful weapon of defence, the use of which leaves us the worse for the fight. They commit great destruction in vineries and orchards, excavating the substance of vast quantities of fruit, leaving the skin and core or stone hanging from the bough so naturally as to baffle detection at first sight. The probabilities are that if you attempt, without due caution, to possess yourself of one of these curiosities of wasp industry and pillage, several hot-tempered thieves will instantly emerge and sting you.

A wasp is a true insect. Its body is

composed of three different portions—the head, the thorax, and the abdomen. A wasp is also the perfect type of an insect, because the portions of the body are separate from each other except for the two slender pedicles which attach them to each other, and the insect has the full complement of appendages developed to a degree of perfection possessed by few other insects.

The principal portions of the head that arrest our attention are the eyes, antennæ, corona, clypeus, and the mouth. The eyes are of two kinds, named simple and compound. The former are very small, like three shining points, black, sometimes marked with yellow, arranged in the form of a triangle with the apex pointing forward, on the top of the head. The compound eyes are one on either side of the head, each composed of about 400 hexagonal-shaped lenses, covered with the cornea or horny membrane, and have many of the same parts as are found in the eyes of larger animals. It is supposed that the compound eyes perceive distant objects and a wider field of vision than the other kind, whose construction would indicate that

they are employed in closer observations. Projecting from the head close to the eyes are the antennæ. The male insect has thirteen joints in each antennæ, the female only twelve. The first or basal joint is longer than any of the others, and the front of it is yellow in each sex of the tree-wasps and of the males of the ground-wasps.

Almost everybody speaks of the antennæ as feelers, and certainly one of their uses is to examine by touch everything they can; they are also used for intercommunication, and as organs of hearing; they may also possess the sense of smell in a greater or lesser degree. How information is conveyed from one insect to another by means of these slender-jointed threads will perhaps never be known, but that they do so is a fact acknowledged by all entomologists. The corona needs but a passing notice. It is a small yellow portion, variable in size and shape, situated between the base of the antennæ. It acts as a strengthening process. The clypeus is immediately below the corona, and is much larger. It may fancifully be termed the forehead, although it serves the

purpose of a shield to protect the tongue and other soft parts of the mouth. Upon it are certain dark or black marks characteristic of the various species, and serving in some measure in the identification of individuals.

The hornet seldom has any mark upon its clypeus, and then only a single brown spot.

The mouth parts consist of upper and lower jaws, upper and lower lips, a tongue, and six minor appendages. The upper jaws, more correctly known as mandibles, are the only parts necessary to notice now. They work laterally, are moved by very powerful muscles, and being serrated on the inner margin, and sharply pointed, are suited for nipping, tearing, and sawing. It will be possible to form some idea of the work these mandibles can perform when considering the methods employed in procuring and preparing the materials used in the construction of the habitations.

The thorax, or chest, is the central portion of the body. It is of very great importance in the insect's economy. Articulated upon it are three pairs of legs and two pairs of wings; it also supports the head and the

abdomen. It appears to be all of one piece, but it is really composed of twelve small portions. Internally there is a wonderful network of muscles, which are used in the control of the wings, the actions of the legs, and operating the salivary glands, the air tubes, and the stomach. The wings are four in number. The pair nearest the head are the largest, and when at rest are folded in half lengthwise, resting on the abdomen with the smaller pair between. When extended, as in flight, they are kept in the same plane by means of eighteen or twenty very small hooks named *hamuli*, which are situated on the anterior margins of the small wings, and so directed that they automatically link into the recurved posterior margins of the larger wings. The six legs are alike in colour, but slightly different in length, the front pair being the shorter and the hind pair the longer. The front pair are furnished with an additional growth which is somewhat like a little brush. It can be controlled by the will of the insect, and when not in use it fits into a depression lined with hairlets in the side of the leg. The antennæ are drawn between these portions

to remove particles of dust, etc., and from this fact they are popularly known as the brush and comb.

The abdomen is composed of segments; seven in the male insect and six in the female. Each segment is divided into a dorsal, or upper half, and a ventral, or lower half; the upper overlaps the lower, and each segment is to a slight extent overlapped by the one immediately in front of it. They are thus of a telescopic nature, and the length of the abdomen is greatly altered when they are extended or contracted. The various portions are held together by flexible ligaments, and controlled by muscles of great strength, and capable of extraordinary mobility. The power of stinging is possessed by the females only; the males have no sting, and are as harmless as a house-fly.

The sting or stabbing apparatus consists of two extremely fine bristles, and a long tubular, sharply-pointed sheath to contain them. Each bristle has one margin serrated at its distal end and terminates in a point of wonderful tenuity. When the apparatus is at rest the bristles are protected within the

sheath, the upper portion of which is connected to the interior of the abdomen. When the action of stabbing takes place the sheath pierces the skin, and the bristles are driven deeper into the tissues of the creature attacked. The muscular walls of the poison gland are then contracted, and the venom is ejected to the extreme tip of the bristles. The construction of the bristles is such that when they are parallel to each other their free edges unite and form a tube throughout their entire length, the serrated portion being on the outer surface. This tube allows the passage of the venom into the wound. The sheath is sometimes left in the fleshy part of the victim, and it can be removed, but the bristles penetrate too deeply, and, owing to the serrated margins and their extreme tenuity, always remain.

Of the seven species of British social wasps, the hornet is the largest; it is also of a slightly different colour. The other species are nearly all the same size and colour. One species does not appear to build at all, but lives as a commensal with another. Three species build above ground,

by preference in trees, bushes, hedges, under the eaves of cottages and barns, and they are known as tree-wasps. The other three species build underground by preference, and to them the term of ground-wasps has been given. They choose subterranean positions, and have the additional labour of excavation added to the task of collecting the materials for the nest or vespiary.

The first rudiments of a vespiary appear in the form of paper-like material, spread upon a branch or the upper part of a hole in the ground; from the centre of it depends a rod of the same material, about half an inch long, with one or more small hexagonal-shaped cells. Every vespiary consists of two distinctly formed portions: the combs, which are moderately hard, and composed of numerous cells arranged in layers; and the envelope enclosing them, which is lighter in texture and more fragile. The materials employed are fragments of sound and rotten wood, vegetable fibres, pilose leaves of plants, filaments of grass, and the rind of young oak shoots; ordinary paper is sometimes used also. Small portions of these substances are

nibbled and moistened with mucus to form a paste, and then carried between the legs to the vespiary, and added to the existing fabric.

Each vespiary is begun by one wasp alone, a female that has hibernated through the winter months. She emerges to activity during the warm days of May, and is known as a queen wasp. If she be then killed, so much the better for mankind. The queen is the foundress of the colony, and she performs most arduous duties for about three weeks. During that period she is obliged to prepare the site, collect all the materials, excavate the cavity, build the structure, form the cells, obtain the nourishment for the larvæ, and feed them, working incessantly from early dawn until long after the shades of evening have bidden other diurnal insects to rest; the hornet does not cease even then on moonlight nights. When the workers develop they take up these duties, and the queen is relieved of all work save that of depositing her ova. That appears to be an insignificant duty until it is understood that a queen of *Vespa germanica* can produce forty-five thousand ova

within five months. Three hundred every day is not a light task!

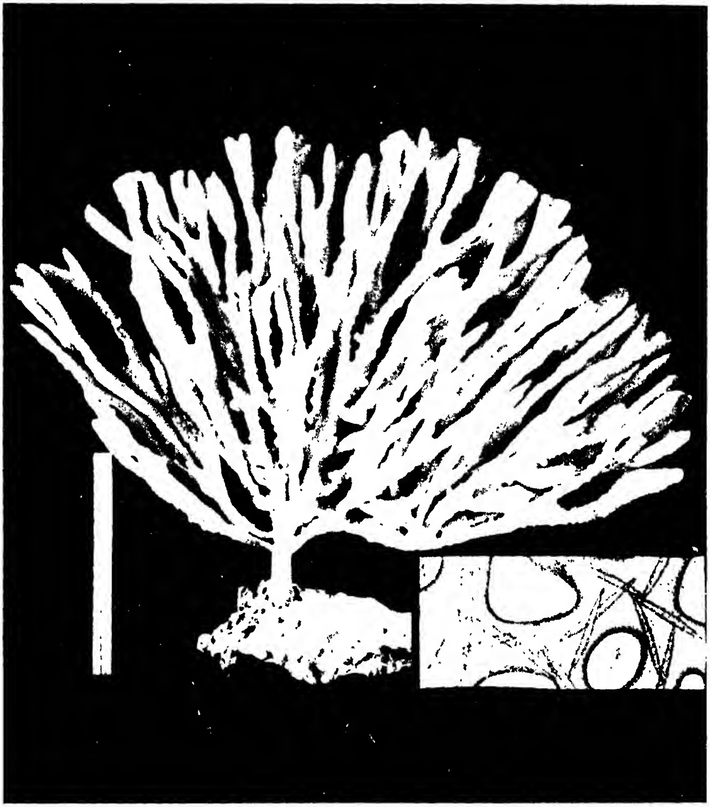
The children are quite as assiduous in the construction of the home as their parent. Many journeys are necessary to obtain sufficient material to cover a square inch. The labour of building does not end there, because as the community increases in numbers so the vespiary must be enlarged. While some of the workers are excavating and removing the earth, others are forming the cells for the reception of ova and the occupation of larvæ hatching from them; and to make room for that, more workers are taking down the inner layer of the envelope, reducing it to pulp, carrying it to the exterior, and spreading it on afresh. Root-fibres of plants are occasionally encountered, and they are nibbled into small pieces and carried away as the earth is; but if too large for removal, they are incorporated with the fabric. In a large vespiary hundreds of workers are occupied in these duties alone, while scores of others are engaged in supplying the wants of an enormous nursery, for which purpose they visit fruit of all kinds, imbibe the juices, return to

the vespiary, and disgorge it into the mouths of the ever-hungry larvæ. Now, it must be remembered that all this labour has to be accomplished with no other implements than the mandibles.

Whatever opprobrious epithets may be hurled at wasps, because, Englishman-like, they defend themselves against all enemies, it must not be forgotten that their industry is not solely for individual benefit and comfort, but to further the interests of the entire community to which they belong; and also that their chief aim in life is the housing and feeding of the progeny, towards whom they show the greatest attention, forethought, and care. Assuredly they teach mankind lessons of energy, hard work, and unselfish industry.

PLATE No. 12.

THE DIGITATED SPONGE.



THE COMMON BRITISH BRANCHING SPONGE.

Chalina oculata, Pallas.

Also a fragment magnified showing spiculæ *in situ* **(After Bowerbank.)**

(The sponge one-third nat. size The spiculæ × 15.)

XII

A BRITISH BRANCHING SPONGE

OF all the many articles of daily use in the home there is perhaps no other so little understood by the stranger to natural history as the common sponge—that porous, tough, resilient commodity used in the toilet and the bath.

But a sponge in the condition so familiar to everybody is merely a skeleton from which another element has been removed. In its original state every fragment of the skeleton is covered with a soft, gelatinous, living material, known as the sarcode body, possessing remarkable powers of life, growth, and vitality. This substance is the actual body of the sponge; and before the sponge is of commercial value, or suitable for domestic use, that substance must be removed. It is composed of enormous numbers of minute

particles, independent to a certain extent of each other, but in an amalgamated condition performing various animal functions, the principal of which is the assimilation of food. Hence a sponge is a living compound animal organism composed of two distinct elements —a skeletal framework and a sarcodic body. It is indeed a body without limbs.

There are numerous forms of sponges, most of them beautiful in appearance, very interesting to investigate, and remarkably diversified in shape and size. When in a living condition they are variously coloured—yellow, orange, brown, red, green, black, etc.

About two thousand kinds of sponges are known to science, three hundred of which may be found in the English seas, one genus only occurring in our rivers and lakes. No English sponge is of any commercial value. There are several reasons for their unsuitability. They do not assume a shape that renders them of any service, nor do they attain a sufficient size. What is more important, the skeleton contains numerous small fragments of silicious material named spicules. The sponge of commerce will not

flourish in a sea whose temperature is below 60 degrees, and consequently the water surrounding these islands is unsuitable.

Although there is no British sponge of use, there is one genus identical with the toilet sponge in texture and structure, yet unlike it in form. The type species of this genus is depicted in the illustration in a skeletonized condition, *i.e.* after all the sarcode body has been carefully washed from it. It grows at the bottom of the sea, attached to rocks, stones, shells, and occasionally on the carapace of a crab, affixed by a compact, hard, cylindrical stalk, the base of which is not much spread, but is very firmly adherent to its object. The stalk or pedicle is variable in height—from 1 cm. to 8 or 10 cm.; it then divides into numerous branches, usually remaining close together, and sometimes touching each other. When there are many branches the sponge resembles a small tree of much grace and beauty. While alive it is a pale, greenish yellow; this turns to a light brown when the sponge is dead and dry.

Many specimens of this sponge are brought

up in the trawl, but promptly thrown overboard. While floating about in the sea the sarcode is dissolved away, the skeleton being ultimately left upon the beach as the tide recedes. They are abundant on all the coasts of England. To be obtained in perfection and of a large size, they must come from the trawl, as did that of the illustration. It was taken on the Diamond trawling ground, a large area of the sandy floor of the English Channel, about fifteen miles south of Hastings.

Not only is *Chalina oculata* the British type of the genus, of which there are seven other species, it is also a good representative of the order of sponges named Keratosa (Greek *keras*, a horn). The word is applied to the skeletal form of sponges, of which the commercial sponge and the species now under consideration are specimens. This keratose material is the horny substance, the framework which supports the body. It resembles silk in chemical composition; its structure is nearly uniform throughout the mass, and growth is rapid. The spongin fibres are joined and interlaced in such a manner that, although flexible and resilient, when torn

apart will not unite again. Hence the action of wringing a sponge to rid it of water speedily reduces it to a fragmentary and useless condition. It should only be squeezed. The sponge of our illustration is of the same nature—soft and woolly to the touch, straw-like in colour, paler at the extremities than at the base, but with numerous silicious spiculæ scattered throughout the fibre. The toilet sponge has no spiculæ in its meshes, or it would be unpleasant to use.

The spiculæ are of two kinds, and vary in length and slenderness. The smallest kind is imbedded in the sarcode body; the largest, in the spongin portion. The parallelogram in the illustration (from a drawing by Dr. Bowerbank) is of a magnified fragment of Chalina spongin showing the spiculæ. It will be seen that they are cylindrical, needle-like objects, with both ends alike, and acute. They are in reality double-pointed needles of flint, the silicious material being secreted from the water and food by the sarcode body. In the centre of each is a fibre of animal substance.

The manner in which a sponge breathes

and obtains its food is very remarkable. It has already been mentioned that the external covering of the skeleton consists of animal substance. If a living sponge be placed in a transparent vessel containing sufficient sea water to cover it, it will be seen that the entire surface of the sponge is perforated with holes. Most of these holes are very small indeed, the others may be large enough to admit the tip of a finger. The name of pores, or *ostia*, has been assigned to the small, and outlets, or *oscula*, to the large holes. If a little coloured fluid, such as carmine, be dropped into the water, it will be observed that the carmine disappears when it reaches the sponge, being absorbed through the pores and then expelled from the outlets; thus showing that it passed into the body of the sponge, and did not return by the same way it entered. In like manner the sea water enters the pores, takes with it oxygen and minute food particles, such as diatoms, infusoria, etc., and after the food materials have been assimilated, the indigestible remains, together with waste products, are expelled from the outlets. This is not accomplished,

however, in the way we might suppose, viz. expansion, to draw the water in; and contraction, to expel it. If a living sponge be cut in half and either of the interior surfaces examined with a powerful magnifying glass, it will be observed that each ostium is merely the external orifice of a minute tube. Tracing the course of one of these tubes, or canals as they are termed, as it proceeds inwards, we find that it does not proceed far before it coalesces with other canals, forming one large canal. This unites with others of a similar size, and a larger canal is the result. Repeated unions of the canals occur until an osculum is reached. As we have traced the course of the canals we shall have noticed various portions of them enlarged, forming cavities within which are many minute substances. These cavities are known as the flagellated chambers. The minute substances they contain are described as cylindrical cells, and the higher powers of the microscope reveal the fact that the upper half of these cells is hollow, and that emanating from the lower part there is a long whip-like thread, or flagellum, which passes through the tubular

half, and projects some distance beyond the margin. The flagellated chambers are very small and very numerous throughout the whole of the sarcode.

The purpose of the flagella is to impel the water along the canals in a uniform direction, always towards an osculum. Their action is that of a never-ceasing spiral or corkscrew movement. Consequently there is a continuous flow of water entering through the multitudinous ostia, circulating throughout the body, and finally forcibly expelled from the oscula. The utility of this arrangement cannot be appreciated too highly. It is one of the most marvellous yet simple devices met with during the study of Nature.

Very little is at present clear as to how sponges digest and assimilate their food. More is known, however, in regard to their reproduction, and also the mode of life during the embryonic stage. Some species propagate by budding. That is, a certain portion grows out from the general mass, and becoming detached, starts life as a separate individual; or cells from the inner layers of the body undergo various transformations until as

embryos they are expelled from the oscula. For several days they move about in the water propelled by means of hairlets, or cilia, upon them, and then becoming affixed to some object, speedily develop into little sponges.

XIII

THE PRIMROSE

NO wild flowers of spring-time give greater delight than the primrose. The common, or dog violet, may be a favourite, but it is devoid of perfume. Although the celandine is bright, it withers quickly; it also is odourless. The anemone speedily droops, and so does the periwinkle. Supreme above all the early wild flowers is the primrose. Few, if any, of our wild plants are more widely known or more thoroughly appreciated. Its faint yet exquisitely delicate perfume, the fragrance of which can best be appreciated from a small bunch of the blossoms, is but one of its many charms. The whole appearance of the plant as it nestles on the grassy bank or unfolds its loveliness among the withered bracken and dead leaves, or the uprising shoots of tender growths at

PLATE No. 13.

PRIMROSES.

PRIMROSES AT BASE OF ASH SAPLINGS.

Primula vulgaris, Hudson.

the base of some bush or tree near the woodland path, is such as will call forth an exclamation of delight from almost everybody.

The colour of the primrose—one of its greatest charms—is very unusual; there is no other British plant quite like it. A pale sulphur-yellow, with five dashes of deeper yellow, sometimes nearly orange yellow in the very centre of the blossom. This is effective alone, but when elevated upon a slender pinkish scape, or stalk, amidst a wealth of lovely glossy green leaves, how vastly its beauty is enhanced!

Primroses are usually found in great profusion. Woods and the hedge banks skirting them, the sides of country lanes, and railway embankments are the favourite spots. The months of April and May are the best to go 'primrosing,' and if there has been much rain during the previous two or three months the blossoms are likely to be very numerous, the scapes longer, and the leaves larger.

In some districts during mild weather these blossoms are fully expanded in the open air on Christmas Day.

The primrose is a hardy plant, and will not suffer from being properly removed from its native haunt, and placed in the garden or rockery. There it will blossom in full vigour, and make the same spot bright and attractive next spring. It flourishes best with dead leaves, or grass, or low herbage around it. It is not partial to direct sunlight all day, nor does it like to be deprived of light and air by big bushes and trees. It is also an early flower.

In botanical nomenclature it is known as *Primula vulgaris*. The generic name is derived from the Latin *primus*, first, and thus we have prime-rose or first-rose, which is indeed a suitable and happy name. *Vulgaris* (common) indicates the wide occurrence of the plant and distinguishes it from cultivated varieties.

The blossom, or corolla, is known in botanical terms as gamopetalous, *i.e.* it is tubular at its lower part and expands above the calyx into five lobes, each of which has a deep indentation in its margin. The calyx is the portion greenish in colour, thickly covered with long, glossy, minute hairlets, with five longitudinal ridges upon it, and

terminating in as many points. It forms a sheath to the tubular portion of the corolla.

In the centre of some corollas is a knob like the head of a pin; that is the stigma. Other blossoms have no pin visible, but instead there are ten reniform yellowish bodies: these are the anthers, which contain the pollen. Hence the flowers of the primrose are spoken of as dimorphic, implying a difference of form in corresponding parts.

In the garden the blossoms and leaves of the primrose suffer considerably from slugs and snails; but in a wild state the entire plant appears to be moderately free from the attacks of larvæ. Apparently the blossoms are seldom eaten. Why this should be so is rather difficult to determine. One reason may be that at the time the blossoms are in their pristine beauty there are not very many kinds of larvæ feeding. Another, perhaps, is that the colour itself may act as a deterrent. Yellow is one of the most universally distributed of all colouring pigments, but, at the same time, it is very distasteful to larvæ and other creatures. It is not unreasonable

to suppose that there may be a degree of acidity dissolved in the cell sap which is distasteful or even injurious to larvæ, or a peculiarity in the constitution of the pigment which warns a lepidopterous parent not to deposit her eggs upon the corolla, calyx, or the scape. Call to mind other flowers with yellow petals—crocuses, daffodils, buttercups, and celandines—how rarely the petals show marks of having been eaten! Observe also how cattle avoid the buttercups in the grazing meadow.

With the leaves of the primrose it is different. The larvæ of at least eight species of moths and one of a butterfly feed upon them. The latter is the larva of the Duke of Burgundy butterfly. The parent insect deposits an ovum on the under surface of the leaf in June, when comparatively few blossoms are to be found. The larva is short, thick, and shaped like a woodlouse. It feeds for several weeks, making small round holes, and then turns into a chrysalis, attaching itself by the tail and a belt of silk around the body to the leaf, and there remains until the next summer.

The larva of one of the moths, the silver-ground carpet, feeds during the autumn, hibernates through the winter, and feeds again in March, when it turns into a chrysalis. The moth is extremely common all over Britain. Another larva is that of a very minute moth, *Phytomyza primulæ*, whose wings when extended do not measure a quarter of an inch from tip to tip. An ovum is laid upon the upper surface of the leaf in the summer. As soon as the larva emerges it consumes the egg-shell, and then eats into the cuticle of the leaf; but so small is it, and so little food does it require, that less than half the thickness of the tissues is sufficient for it to live in, and yet have a covering above it. By the autumn it will have produced a tortuous and continually widening line, visible only on the upper surface of the leaf, and measuring, if it could be straightened out, as much as 4 or 5 inches in length. The name *Phytomyza* means 'plant-sucker.'

The shades of green in the leaves of the primrose are very beautiful. Some leaves are emerald green, some have a yellowish hue, while others will approach an olive green.

The under surface is always much paler. Some are recumbent, almost level with the ground; some lying upon it; others are erect. But leaves and scapes all spring from one common centre, viz. the apical part of a strong main root, from which there branches off in all directions in the ground numerous long fibrous rootlets. The shape of the leaf is lanceolar. The succulent mid-rib, narrow and thin at the apex, gradually enlarges towards the base of the blade, where it forms a large and thick footstalk. Its distal portion is sometimes almost yellow, while a good part of the basal end is frequently a pink colour. In its centre is a greenish-yellow, elastic, medullary thread. The upper surface is smooth and bald, deeply incised by the lateral off-shoots of the mid-rib and the net-work between them. The corresponding elevations on the other surface are thickly beset with greyish, glossy, microscopic hairlets, which impart a soft appearance. The margins are very finely serrated and bent back.

It is said that the larva of the silkworm will feed upon the leaves, and thrive as well as upon those of the lettuce. Since the

former can be very readily obtained, young people who rear silkworms might try the effect.

In the days of extensive herbal remedies the roots were used as an emetic, and the leaves and blossoms for various ailments.

The plant appears to be remarkably free from enemies and diseases. No insects produce galls upon it. Fungus, in its many forms, is seldom seen on any portion of it. Various vagaries and malformations may occasionally be observed. The most common, perhaps, being: the lobes of the corolla divided into six, seven, or eight parts; fasciation, *i.e.* the cohesion of two or more scapes; digitate separation of the calyx, and of the corolla; double flowers; the corolla suppressed, and the calyx continuing its growth and forming five small green leaves. But, more rarely still, a tuft of delicate little leaves will develop at the summit of the scape, intermixed with a few small flowers. Sometimes a plant will be found in which the blossoms are pink. The cause for that does not appear to be known. In some localities of South Wales many hundreds of

plants of the pink variety may be met with, but the typical colour is always abundant.

There are many intermediate hybrid forms between the true primrose and the cowslip, which is an allied species, having the blossoms arranged in a cluster, or umbel, upon the scape. The corolla is smaller and of a deeper yellow than that of the primrose, and it contains more nectar. It is not so widely distributed as the primrose, nor is it found in so great abundance. The oxlip is a variety of the primrose; it resembles the cowslip.

PLATE No. 14

A REMARKABLE POLYZOON.

A MASS OF THE STONY FOLIACEOUS CORAL-LINE *Lepralia foliacea*, Ellis.

Also a photo micrograph, 40, of a fragment

[illegible]

XIV

THE STONY FOLIACEOUS CORALLINE

OF the many curious and little-known objects brought up by the trawl-net from the depths of the English Channel, not many are so peculiar in shape and appearance as that which forms the subject of this study.

An illustration, no matter how excellent, of a piece of *Lepralia foliacea* conveys to those who never have seen it in nature only a somewhat confused idea of the object. The illustration, with its many imperfections, may, however, assist the reader in recognizing the object on some future occasion.

In the study on *Flustra foliacea*, it is said that each frond consists of an aggregation of countless small polyps, each individual surrounding itself with a covering of corneous

material (which is the exo-skeleton), forming a cell or zoœcium. In the course of forming the zoœcium the polyp does not, however, cover the cells of other individuals which surround it, but places it either by the side or above its neighbour; they also arrange themselves back to back, both surfaces of the frond being alike.

The Lepralia is similar to the Flustra in several particulars; *e.g.*, the cells or zoœcia are arranged in the same manner; the animal itself is similar in size and form; the place of dwelling is alike in both, viz., from just beyond low tide, to a depth of about 300 fathoms; and they both grow upon similar objects on the floor of the ocean.

There are, however, at least three details by which the two objects are separated, and consequently placed in different genera, although their specific names are the same.

The fronds of the Flustra rise from a common base, and, although they branch somewhat freely, they remain quite separate from other branches around them. Lepralia has no free and independent fronds or branches, but its leaf-like portions meet and

join with other fronds, forming cavities of great irregularity in size, shape, and depth, subject also to much contortion, a phase of growth widely different from that of Flustra.

Another prominent difference is that while the fronds of Flustra are pliant, those of Lepralia are rigid and unyielding in any portion. A third distinction is that after being detached from its place of growth, Lepralia remains on the sea-floor, while Flustra is suspended in the sea until finally cast upon the shore during some rough high tide.

The excessive fragility of any projecting portion of Lepralia is the despair of whoever desires to possess an undamaged mass. The writer's experience is that it is a matter of extreme rarity to obtain an absolutely unbroken specimen; and an inspection of the examples in the National Museum supports the remark. And to this must be added that the polyps are never found alive unless the Lepralia mass be obtained direct from the trawl, and but a very short space of time elapse after it has left the sea.

There are seven British species of Lepralia; that now under discussion (*foliacea*)

being the most widely distributed, and most frequently seen. Apparently it occurs in all the seas surrounding the British Isles, except at the extreme north of Scotland.

The generic word is derived from two Greek words, one signifying scurf, the other, marine. Now the former word would not at first thought appear to have any bearing upon the characteristics of the object. Taken in the Anglo-Saxon sense of the word, scurf means 'anything adhering to the surface,' and in that we shall find a solution of the difficulty. The habit of growth of *Lepralia foliacea* in its initial stage is that of spreading in an incrusting manner upon stones, rocks, shells, and other marine objects, and *afterwards* rising into foliated expansions, as depicted in the illustration. Four species remain as flat, compact, circular crusts or scurfs upon annelid tubes, in addition to objects previously indicated, and to them the term of scurf is perfectly applicable. The popular name given to it by Ellis, many years ago, is the stony foliaceous coralline.

Large specimens are brought ashore to Hastings and other South-coast fishing towns,

and many specimens of great size are obtained off the Cornish coast. The largest recorded was dredged from near Eddystone Lighthouse a long while ago. The mass was 21 inches in height and 7 feet 4 inches in girth. The polyps inhabiting the specimen must have been as numerous (or more so) as the ova in the roe of the ling fish.

When a specimen is first obtained from the sea the basal portion is a dull brown colour, while the remainder is a very pale pink or delicate flesh-colour; this represents the parts where the polyps are alive, the former where they are dead. If the specimen be allowed to dry, the polyps at once die, the entire structure then becomes of uniform brownish hue, with a strange but beautiful vitreous appearance.

Chimerical as it may seem, it is nevertheless quite correct, that these masses are built entirely by the secretive action of minute animals known individually as a polypide or zooid, and belonging to the great phylum of Polyzoa. The word 'Polyzoa' signifies an association of animals, remarkable on account of their habit of forming extensive

colonies by a process of budding, such buds being permanently retained in organic connection. These colonies are mostly compound aggregations of individual cells arranged upon a definite plan, each cell being made by the polypide which inhabits it.

The various organs of the animal are enclosed within a gelatinous exo-skeleton, which forms a cuticle known as the ectocyst; the case which the animal forms, and within which it can completely retreat, is the cell or zoœcium; and the compound colony—the entire specimen—is termed the zoarium.

We will endeavour briefly to trace the life conditions of *Lepralia foliacea.*

It reproduces itself in two ways. One is by true ova normally developed. Under certain conditions of temperature, unfavourable to development, the ova do not yield young for some time; otherwise the young speedily emerge. The young creature is a peculiar little object which is named a larva. It has a free existence, moving through the water by means of minute hairlets or cilia. The purpose of the roving condition indicates a provision against overcrowding of colonies

within a given area, with a consequent insufficiency of food supply. The roving condition varies in duration, but ultimately the larva settles upon some marine object by means of a ventrally situated suctorial cavity, and forms around its hitherto unprotected body a coating of coriaceous and calcareous material. This is the zoœcium. The shape of the zoœcium, and also the tentacular form of the animal, enables the student to determine the species.

The zoœcium of *Lepralia foliacea* is described in a standard work on Polyzoa as 'ovate-elongate, or rhomboid, quincuncially arranged, separated by lines, very moderately convex; surface punctured and often nodulose, the punctures frequently surrounded by thick, reticulated ridges, sometimes areolated round the margin; orifice-arched above, contracted a little below the middle, where there is a small denticle on each side, the lower margin almost straight, or very slightly elevated in the centre.'[1]

To many persons much of this description may be meaningless, but those who can

[1] T. Hincks, *British Marine Polyzoa*, vol. i., p. 301.

devote a little time for the purpose will recognize most of the features in the photomicrographic circular portion of the illustration — the quincuncial arrangement being easily understood, if attention is directed to the orifice exactly in the centre of the circle, the four other orifices completing the quincunx, situated in relation to it like the points of the compass. The punctured surface of each zoœcium is also unmistakable; the separating lines, however, are not seen. An orifice is the opening through which the tentacles and a portion of the body of the polypide are protruded and withdrawn.

The polypide, being firmly fixed, grows very rapidly, and soon begins to form buds. This form of budding is known in science as gemmation. It is very extensive among the lower and smaller forms of marine life. The buds are portions of the polypide produced by overgrowth. They are permanently fixed to the parent and to the object upon which they rest, and remain in vital union with their progenitors. Each bud rapidly becomes a complete and mature polypide or zooid surrounded by a zoœcium; this in

turn buds in like manner, and ere long a membrano-calcareous crust, inhabited by zooids, has spread in all directions upon the object previously occupied by one individual only. Upon this encrusting area raised ridges soon appear, which are the result of incessant gemmation of the procumbent zoœcia. Having produced a firm base of attachment, the zooids continue to erect the foliated, lamellated, contorted and chambered zoarium, never ceasing until removed from the sea; every superficial square inch of which contains on either surface 4275 zoœcia.

It will be realized from these figures that each zooid is extremely small. It can only be discerned with a lens or a microscope. In a living and expanded condition, while immersed in sea water, it is of fascinating elegance, with its incessantly moving tentacles. These tentacles are ciliated, and contain cells with stinging threads, by means of which food is captured and retained. They also perform the function of gills or lungs, since the fluid in the body analogous to blood circulates through them, in order to become purified. The tentacles engirdle the mouth,

from which there extends a tubular alimentary canal curved like the letter U, and divided into three portions: the ciliated œsophagus, the stomach, and the intestine. The extremity of the canal is in close proximity to the mouth, but outside the circle of tentacles. The portion of the body containing the various organs which may be popularly termed the skin is composed of several layers, the external layer having the power of secreting the material to form the zoœcium.

The nervous system is simple, consisting of nerve cells, which send out fibres to the tentacles, mouth, œsophagus, and other organs.

There is neither heart nor vascular system.

The various sets of muscles are wonderful in so small an animal, nor will anybody be surprised at the high degree of complexity, when the rapid and varied movements of the zooid have been watched. 'For the mere act of retraction a whole apparatus of muscles is required; and, in addition to this simple movement, the remarkable mobility and varied play of the tentacles as a whole, and of an individual tentacle, involves a special service.

A distinct set of muscles is needed to assist in the withdrawal and stowage of the alimentary canal, another to steady it and hold it in its place when extended, and yet another to secure the contractility of the inner wall, on which the protrusion of the polypide is largely dependent. In addition to all these claims the various regions of the digestive system must have their own supplies of contractile tissue, to enable them to discharge their respective functions efficiently. The power of rapid retreat is essential to the safety of the polypide; and hardly less essential is the perfect mobility of the tentacular wreath; and nobody can have watched a living colony without seeing how admirably these are provided for. At the slightest alarm the exquisite bells collapse and vanish on the instant.'[1]

But the builders of this remarkable structure are seldom allowed the sole possession of their labour.

The rigid nature of the zoarium forms an excellent support for several species of tube-making Annelids, who rear their sand and

[1] T. Hincks, *British Marine Polyzoa*, vol. i., p. xxix.

stone-composed habitations in closest contact with the sides of the zoarium, smothering hundreds of the zooids in their ever-increasing height and width. Numerous forms of other Polyzoon creatures spread their zoœcia regardless of the lives of those they for ever shut out of sight and existence. Many long, delicately formed, and elegant growths of Hydroids also find a secure and welcome attachment; they add grace and beauty to the structure, and are less murderous than the Polyzoons and Annelids.

The cavities in the zoarium become a haven of refuge or concealment for a host of various small marine animals. Young forms of several species of crabs, small starfish, sand-stars, brittle-stars, Echinoderms, and other creatures galore, skulk and hide in the crannies and crevices, until the structure becomes a veritable lodging-house; an example of a struggle for existence, and an object-lesson of 'the survival of the fittest.'

It is not until an old specimen, very much overgrown and well stocked with vagabond tenants, is plunged into cold fresh water, that it is possible to realize the state of

overcrowding. The fresh water, which is poisonous to most forms of marine life, causes the active creatures quickly to forsake their retreats in search of—what they cannot find.

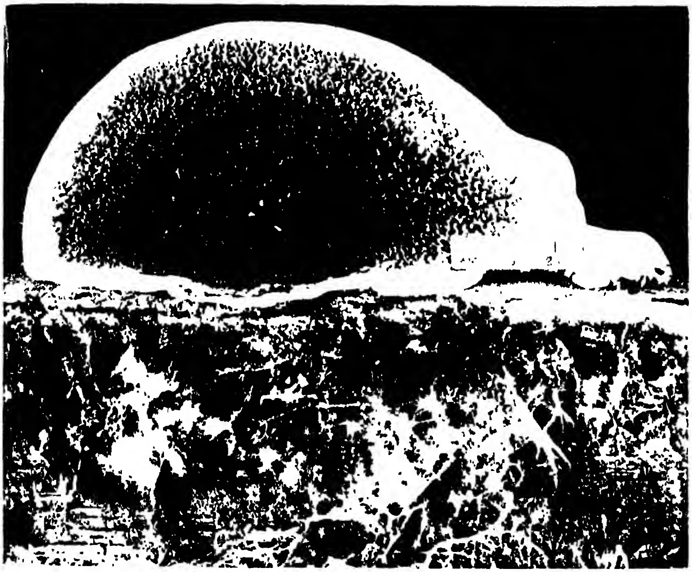
XV

THE DRY-ROT FUNGUS

THE extraordinary manner in which the woodwork in some houses becomes decayed is but little understood by a large number of people who see the rotten woodwork. The joists and the boards of the floor are suddenly found to be weak, and in places the floorboard may easily have a hole made in it by a hard substance, such as a broom-handle, being pressed upon it.

Many householders are, however, aware that when such occurs the softness of the wood is the result of dry-rot, and that the decayed parts must be replaced with new wood. This is not always a remedy for the complaint, because any wood that is left may contain germs of the disease, which will continue to spread. The mischief has been done, and the soft, useless condition of the wood is the

THE DRY-ROT-FUNGUS.



A PLANT OF THE WEEPING HOUSE-FUNGUS.

Merulius lacrymans, Fries Causes dry-rot in wood.

Also a piece of wood showing mycelial threads and strands.

(*Four-fifths nat. size*)

result of circumstances past and irremediable, as far as that portion of the floor is concerned. It is sometimes difficult to eradicate, and costly to repair its damage. Several coats of creosote (common coal-tar oil) or a carbolic preparation are not only preventatives of wood being attacked, but they will also arrest the spreading of the fungus.

There are several kinds of fungi destructive to timber. *Polyporus vaporarius* and *Merulius lacrymans* are two kinds, very much alike, very prevalent, and do much damage. Of these two, the latter is the more destructive.

Dry-rot is caused by a fungoid plant which grows on the trunks of fir, pine, and oak trees in Continental forests. It is not common in English forests. It also grows in damp places in houses, and, under certain conditions, luxuriates in such spots. The term 'dry-rot' is generally applied to those forms of decomposition in structural timber (*i.e.* joists, floor-boards, skirtings, etc.) where the cause of the destruction is not visible to the naked eye. But while some of these destructive fungi are inconspicuous, because their fine thread-like growth remains in the substance

of the wood, others force themselves upon notice because they develop a luxuriant growth outside the wood, in such places as cellars and cupboards. Each kind derives its nourishment from dead organic substance, such as timber, decaying vegetable matter, and because of this they are named saprophytes, to distinguish them from those fungi that derive their food from living substances, and are known as parasites.

In order the better to understand the life-history of the dry-rot fungus, a few features of fungi in general should be observed.

A fungus is botanically a plant. There are not fewer than 4900 species of fungi to be found in Britain. This enormous number forms but one group of a main division in Botany of plants bearing the name of Cryptogams, a pronounced feature of the division being that they are devoid of chlorophyll—the green substance in other plants. The tissues or fungi consist of rows of cells, some of which are very long and continuous. Each cell is known as a hypha. This word is from the Greek for a web, and it provides an indication that the cells are thread-like. When the cells become entangled and

interwoven, the film or network they assume is termed the mycelium. This latter is variable in its final state; some forms are as hard as wood, others cork-like; but that of the *Merulius lacrymans* is soft and floccose. The mycelium is the vegetable portion of the fungus, and the part from which the spores emanate.

A question that very naturally arises in the mind is, how does the fungus get into the wood? It can only be correctly answered by tracing the wood back to the forest, because the fungus mostly originates there. Since the wood used in house building in England is imported, it is to Continental and American forests that enquiry must be directed.

When trees are felled the bark is peeled off, and the logs usually allowed to lie on the ground. After a time they become dry and crack. Some cracks are an inch or more deep. The minute seeds or spores given off by fungi on other trees, and floating about in the air, settle on everything around, the prone logs included. When rain falls the spores are carried into the cracks and there lodged, the rain causing the wood to swell, and the cracks

to close. If there is a prolonged wet season, or the timber is not removed for a long time, the spores germinate, the wood becomes brown, and decomposition begins.

There is a part in the tree, however, where the spores do not germinate so readily. It is the alburnum part. It is the soft-sappy zone between the inner bark and the heart-wood. The spores find their way to it, but do not germinate in the forest, because when the rain ceases the surface of the wood quickly dries, so that if the cracks should have closed, they speedily re-open, and the spores are dried by air and wind. When this kind of wood is taken to the saw mills it remains sound, but the spores retain their vitality. The wood may be transported to the opposite hemisphere, used in buildings for joists, floorboards, skirtings, cupboards, and such like, and remain to all appearances perfectly sound for many years, but so soon as favourable conditions arise, such as excessive damp, a continual humidity of the atmosphere of the room or cupboard, the spores germinate, growth proceeds, the fungus increases rapidly, and it will spread from the

basement or cellar to the topmost floor of the house.

This wonderful vitality seems almost incredible. The extreme minuteness and prodigious quantities of the spores must be taken into consideration. According to Professor Hartig, of Munich University, they are 'so small that about 65,000,000,000 (sixty-five thousand millions) can be contained in 25 cubic millimeters of space. Every spore contains nourishment—which has been derived from the parent plant, and which is instantly available for use.'[1] The Professor has further shown that each spore has a hole or germ aperture, which, when the spore is thrown off from the plant, is 'closed by a clear lustrous plug.'[2] The spore does not germinate until the plug dissolves. This not only takes place under any favourable natural condition, but it has been demonstrated that the addition of 'ammonia, or salts of potash, or soda, to the infusion in which spores are placed,'[3] will cause them to start into immediate activity.

[1] Hartig, *Diseases of Trees*, pp. 221, 222.
[2] *Ibid.*, p. 222.
[3] *Ibid.*, p. 222.

It is while the timber lies in contact with the ground that it is in the greatest danger of being attacked. It should be piled upon supports, so that the air may freely circulate along it. When the timber is transported to saw-mills by river, in the form of rafts, or floated, as it is termed, it becomes fully saturated with water. Upon reaching the mills, it is allowed to dry sufficiently for cutting, and if the fungus spores are present, when the wood is dry there appears what is well known to all who deal in wood—red-stripe. This is the first stage of dry-rot. At least one-third of the logs are thus affected. The red-striped boards are, however, often used in buildings, and will remain serviceable until moisture has access to them; then the spores develop, and the destruction of the wood continues apace.

The fungus has acquired the name of dry-rot because of the condition to which the wood is reduced after the fungus has exhausted its energies upon it. The plant itself is never dry until it can draw no further nourishment from the wood, and consequently dies. Therefore, dry-rot is by no means a

suitable name. It can only grow in wood while there is sufficient moisture. But when started it spreads to sound wood, and causes destruction, carrying with it the necessary moisture, which, when in excess, appears in the form of small clear drops of water. The purpose of the self-produced moisture is that surrounding dry wood may be rendered suitable for the further spread of the fungus. The drops also give the fungus the appearance of shedding tears, and has caused it to be named the weeping house-fungus, and that feature doubtless influenced the distinguished naturalist Fries in bestowing upon it the specific appellation of *lacrymans*, the Latin signifying crying. The generic name is *Merulius*.

The general form and appearance of a medium-sized plant of *Merulius lacrymans* is represented in the illustration. It may, however, attain any size up to 35 cm. in diameter and 3 cm. in thickness. At first the plant is white, soft, tender, very light, and woolly. This soon changes, leaving the outer margin white or pale yellow, smooth, silky in appearance and touch, and is also

sterile, *i.e.* does not produce spores. The inner part is formed into irregular folds, which, when covered with spores, is a dark orange colour. Its substance is slightly gelatinous. It is not poisonous, and some people consider it to have a pleasant flavour.

The plant usually grows upside down beneath a board or shelf, or it will develop in a corner, with part attached to the shelf and part on the fillet. Such was the position of the specimen illustrated, which, with several others, grew in a cupboard in the writer's house. Its growth had been carefully watched and photographed when in its prime and in the weeping stage. The reflection of light upon the drops of water shows as white specks in the centre. It is resting upon a piece of the skirting of the cupboard, showing the inner side, with the mycelium forming a thick felt, and very much the appearance of being covered with masses of spiders' webs.

When the plant reaches the stage shown in the illustration, it is known as a sporophore. When in a living condition it has a somewhat pleasant although fungoid perfume, but when

decomposition sets in, a very disagreeable odour is given off, which undoubtedly is injurious to the health of people inhabiting the rooms. When the sporophores are numerous or very large, they give off a great amount of water, which causes the rooms to be very damp.

The manner of growth is not accidental. The drops of water falling from a sporophore moisten whatever is beneath it, and accelerate the growth of the spores which have already fallen upon the same place. Without such a combination the spores would frequently be abortive. The spores are a reddish brown colour.

When the spores germinate they throw out minute filaments, which penetrate the wood and ramify in every direction, abstracting their nourishment from the starch and other substances in the cells, and also dissolving the cell partitions.

As soon as the mycelium dies the wood becomes dry; it cracks, turns brown, soft, and rotten, and will easily split into oblong and cube-shape pieces. In the lower left-hand corner of the illustration there are indications that splitting has begun.

The mycelial threads will grow out of the wood, if the surrounding air is sufficiently humid, and form a dense flocculent covering. They also spread in all directions, creeping up walls and through chinks in the bricks and woodwork. If as they advance they get far away from the humid atmosphere, they draw moisture from the point of origin. Other threads follow parallel with the forerunners, until strands are formed sometimes 2 cm. in diameter, extending many yards in length, and covering wide areas. At favourable points sporophores develop and spread the disease still further. The strands also convey water from other parts of the building, so that when dry and sound wood is encountered they soak it, and make it suitable for the growth of sporophores. The appearance of the flocculent mycelial threads, and also strands of small size, are clearly seen in the lower part of the illustration.

This fungus is of a highly infectious character. Spores may be conveyed to sound wood, causing great destruction. Timber from old houses stored beside new wood will affect the latter. Spores may be carried on

a person's clothes and boots from place to place, and doubtless mice, by means of their fur, also convey spores from house to house.

There is also a saprophytic wood-fungus which produces green-rot. It affects much decayed oak and beech wood in a wood or forest when constantly soaked with rain. The colour is an intense verdigris green. This is extracted from the mycelium and the sporophores, and on account of its permanency is used in arts. This fungus is rarely found in houses.

XVI

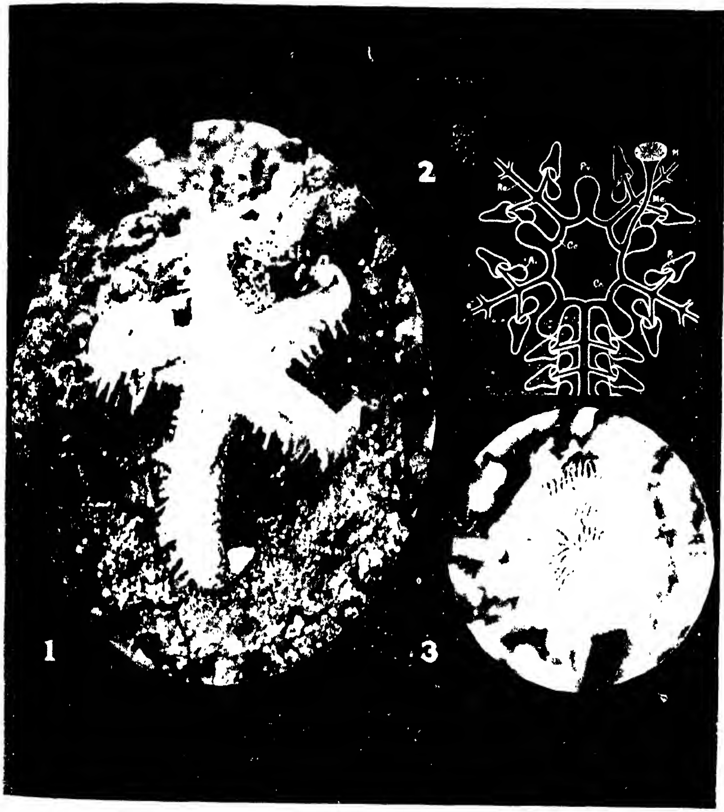
THE FIVE-FINGERED STARFISH

IT is a most pleasant change from the ramble in the country to go on to the rocks at low tide. On a hot day it is always cool and refreshing there. The gentle ripple of the wavelets as they lap the rock at your feet, and the gurgle of the water as it rushes through some well-worn miniature gorge, are pleasant to the ear. And perhaps some frisky little billow flings itself upon a large boulder near by, and laughs with glee as it suddenly breaks into countless beads of spray, and showers them upon you like liquid pearls.

In the companionship of the sea one can muse on unseen things, revel in the beauty and wealth of life in the rock-pools, and meditate upon the uncontrollable force of the tides. Said a preacher once, 'God's thoughts

PLATE No. 16

THE COMMON STAR FISH.



THE STAR FISH, CROSS-FISH, OR FIVE FINGER.

Asterias rubens, Linn.

1 Photo. *ad nat* of the animal, on the rocks, turning over. *One-third nat. size.* 2 Diagrammatic representation of water canals *Half nat. size.* 3 Photo micrograph of the Madreporite, 5.

are in the rolling of the sea.' Little wonder that man so imperfectly understands the mysteries of the mighty deep!

There is but one way to pursue the study of Nature. That is along the highway of love. Wordsworth has cheered the traveller along that way.

> '. . . Nature never did betray
> The heart that loved her. . . .'
>
> (*Tintern Abbey.*)

But there are also qualities, twinlike in character, necessary in order intelligently to walk the by-paths—patience, perseverance. And these qualities are most essential when the attention is directed to marine life. The more minute its form the wider the scope for patience and perseverance to be displayed.

Some marine creatures are never in a hurry; others cannot hurry if they wanted to do so; while other kinds evade your quickest movements, vanish from your gaze, and escape pursuit in a most tantalizing manner. Of the former nature is the commonly named starfish. Strange misnomer that word fish! Compare the creature with a plaice, mackerel, or codfish. Is there the slightest

resemblance? No. Yet there is no other word by which the creature is so well known, as the starfish. When seen in its native state, on the rocks, in a shallow pool, or even on the sands, it appears as though unfit for its place in life, yet it is prepared in every way to hold its own amongst the denizens of the sea. It will, even if torn into five portions, ultimately become five complete and separate individuals. No fish will eat it.

The starfish is found in all European seas, and on all the coasts of the British Isles, in some districts abounding in great profusion. It prefers rocky localities, and has no objection to being uncovered by the sea at low tide. It creeps about the rocks, along the sides of harbours, pier piles, and groynes, and also on the sands. It is immensely destructive to oyster culture.

The normal colour of the upper surface is orange red, much paler along the margins of the rays; variation, however, is considerable, some specimens being pale yellow, others deep red, and also purple. Some forms taken from the deep sea are jet black, brown, yellow and red, yellow and brown, pink, and also

grey. The colours fade after the death of the animal, and, unfortunately, they cannot be retained in their original brilliancy, because the colouring will dissolve in any preservative fluid. A carefully-dried specimen is interesting, but, with the skin removed, the skeletal framework is a beautiful object.

A specimen of average growth will measure six inches from tip to tip of opposite, or nearly opposite, rays, and be about three-quarters of an inch thick at the disc.

We will now inquire somewhat into its status, its origin, mode of life, and the economy of so strange-looking, yet so wonderfully constructed a creature. It has at least three popular names: starfish, crossfish, and five-finger. In classical nomenclature it has also several titles, that given to it by Linnæus being the one now in general use, viz. *Asterias rubens*. It is a member of a group of fourteen individuals whose family name is Asteridea, so termed because the bodies of most of them are formed more or less in the shape of a star; and this family is amongst many more of the phylum or division in Nature known as the Echinoderma,

Here we have two Greek words blended, one *echinos*, a hedgehog; the other *derma*, skin. The mention of hedgehog will convey to the mind the fact that the derma of the Asteridea is rough, spiny, and prickly. The derma is more correctly known as a tergal skeleton. It is composed of small pieces or plates of carbonate of lime, some bearing spines, others smooth; there are also other portions like bars, which unite the plates and form a network, held together on the outside by a membranous covering.

The starfish originates from an ovum, from which when it emerges it is very peculiar in shape. It is then known as a larva, and it can swim about freely. Its early conditions are not fully understood, but it is known that 'a portion only of the body of the larva is converted into the substance of the perfect animal; the rest is either absorbed by the growing animal, or shrivels and disappears';[1] and also that it passes through a series of remarkable changes before it reaches the stage familiar to the general observer.

[1] *Guide to Shell and Starfish Gallery, British Museum* (Natural History), p. 111.

The body of a mature starfish consists of a central disc, from which radiate portions diminishing in size and ending in a blunt point; these are known as rays. Ordinarily there are five rays, but there may be four or six; specimens are sometimes found with eight, and malformations are not uncommon. The mouth is in the centre of the under-surface of the disc. It is in no way comparable with the mouth of most other animals; it is merely a small opening without teeth.

The margin of the opening is protected with a few spines. Immediately within the mouth is the stomach, which not only occupies the larger portion of the disc, but extends along each ray also; it is yet more remarkable on account of its extraordinary protrusile nature, to which reference will again be made. The creature is moderately well provided with nerves. The system consists of a cord around the gullet, with branches traversing each ray. At the tip of the ray the nerve terminates within a small tentacle, the extremity of which contains a large number of minute ocelli. Presumably they possess the power of vision

to some degree, since these objects are termed eyes.

The starfish is a slow-moving animal, but when disturbed it will accelerate its movements. The motile apparatus is along the under-surface of each ray. In order that its mode of action can be understood, the animal in a living condition should be placed upon its back. It will then be seen that in a middle line from the centre, or mouth, to the tip of each ray, there are in constant motion a large number of long, thin, exceedingly flexible and mobile, tentacle-like tubes, each terminating in the form of a sucker. These tube-feet are variously named—suckers, pedicels, papillæ, and podia. They are intensely sensitive. The arrangement is that of four in a row, and generally there are fifty rows in each ray, and by their combined action enable the animal to progress from place to place. Each ray is in reality a simple but most effective organ of locomotion, and because of this fact the rays are known as ambulacra. Each can act independently, or in conjunction with its neighbours, and with the

thousand feet in unison the animal can progress with great facility in any position.

Fig. 1 in the illustration is a photo of a starfish on Bulverhythe Rocks, in the act of righting itself after it had been purposely put on its back. It will be seen that the manner in which it accomplishes this is by bending over the tips of two or more rays, and causing the sucker tips of the feet to affix to the surface beneath them; as these exert a drawing power on the body, other podia become attached, and in the course of a few minutes the animal has completed the movements and assumed its normal aspect. Many of the podia can be distinguished actually affixing themselves to the rock. To assist us in realizing how this is performed, reference must be made to the square portion, Fig. 2, in the illustration. It is a diagrammatic representation of the canal or aquiferous system for the circulation of water throughout the body, and it furnishes an explanation of the motific and controlling power of the ambulacral areas. The lines running parallel to each other represent tubes or canals through which

water circulates. It will be noticed that the central oval canal, marked CC, opens out into five pouch-like formations, PV (polian vesicles), and it also branches off into five other canals, RC (radial canals), which divide on either side into double pouches, A (ampulla), and P (podian tubes). A most important part is now to be noticed, viz. the trumpet-like tube, the madreporite, M. This portion opens out on the upper surface of the animal, not far from the centre. Its position there is revealed by a small elevation something like (to the naked eye) a tiny button of about 5 mm. diameter. Its true appearance is shown as seen under a microscope at Fig. 3. This madreporite is a nearly circular and somewhat hemispherical object, elevated slightly above its surroundings. It is composed of numerous thin white laminæ of carbonate of lime, which, radiating from the centre, branch into pairs at intervals.

The pouch-like vesicles, PV, are reservoirs, which expand or contract according to the number of podia in use. When, therefore, the animal is at rest, the vesicles

and canals are full of water; immediately there is a desire to locomote, muscular contraction takes place, and the water is forced from them into the podian tubes, P, which, assisted by their own muscular power, become distended into sucker-like organs of movement.

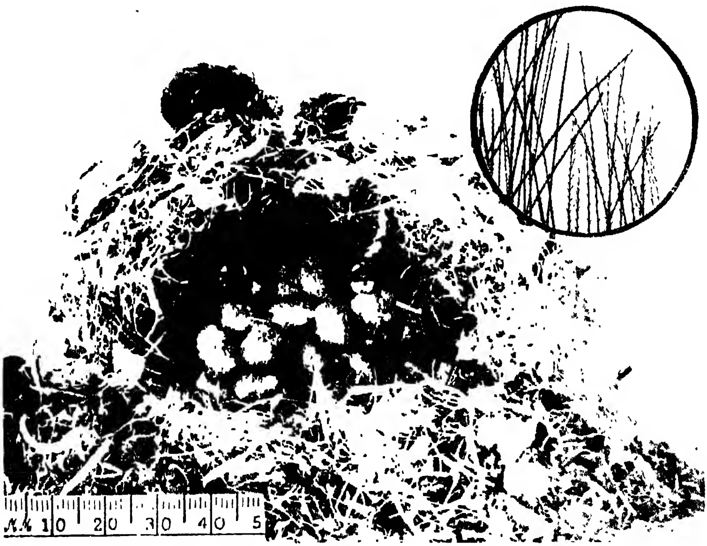
But if the mode of locomotion of these animals is singular and wonderful, much more so is the method by which they obtain nourishment. It might not at first appear as though there could be any analogy between the starfishes on the rocks and sands and the empty mussel and cockle valves on the beach near these respective localities; but there is. The food of the starfish is very extensively molluscan. That has been known for ages past, and the enormous destruction they are responsible for in oyster-beds is a proof of it, but how the mollusc was extracted from within the closed valves was a mystery until about twelve years ago. It is now fully understood. We select the mussel in particular, because it may be so readily found upon the rocks, and the starfishes' action witnessed by a patient

observer. First the starfish clasps the mussel shell in its rays, so that the opening of the valves is in contact with its mouth. Then begins a literal tug-of-war, the bivalve seeking to keep the shell closed by the contraction of its adductor muscles, the starfish endeavouring to overcome the tension and separate the valves, for which purpose the podia attach themselves to the valves and the rays draw apart in opposite directions, operating with a continuity that ultimately overcomes the resistance of the mussel. The long protrusile stomach of the starfish is then inserted, and the body of the mollusc sucked up through it until there is nothing left within the shell except the muscles used in opening and closing the valves.

The writer has on more than one occasion witnessed starfish feeding.

PLATE No. 17.

HUMBLE BEES.



A VESPIARY OF THE WILD BEE.

Bombus hortorum, Linn.

Showing the cells and some of the inhabitants.

Also a photo-micrograph, 10. of branched hairs upon the body.

(Four-fifths nat size.)

XVII

ONE OF THE BRITISH HUMBLE-BEES AND ITS HOME

ONE of the most familiar sounds to be heard in the country on a summer's day is the hum of bees, and equally as familiar is the presence of the large hairy bees known as *Bombi*. They go from flower to flower with heavy, lumbering flight, making a loud buzzing noise, as if saying, 'Please get out of my way; I'm on business, and in a hurry.'

Some of the *Bombi* are giants in comparison with the small but equally industrious hive-bee. They are active and energetic, and perform a service to man only a little inferior to that accomplished by the hive-bee. Their mode of life, however, is not like that of the latter bee; the shape of the larval cells is different, the construction of the nest, or

vespiary, and the conditions under which they live are quite distinct. Only in one particular do they coincide, and that is the social condition of their communities; but even in that there is a variation—the individuals are never so numerous as those in an ordinary apiary or in the vespiary of a wasp. They live a natural life, and it is doubtful whether, if attempts were made to treat them in the same manner as the hive-bee, they would be successful, and the honey production commensurate. The honey produced by the British wild social bees is, as a rule, very sweet and fragrant, but it is sometimes injurious to human beings. It is not considered safe to use because some of the nectar is obtained from the flowers of plants whose active principles are distinctly poisonous to mankind.

Bees are included in the order of Hymenoptera, so named because the four wings are skin-like or membranous and destitute of scales, like the wings of butterflies and moths, or hairs, like those of flies. Bees (in unison with wasps and ants) are grouped under the term aculeate, a word meaning a spine or a

prickle. We have therefore a group of winged insects known as Aculeate Hymenoptera, because of the nature of their wings and the ability to sting or stab any other animal.

The genus Bombus—of which there are eighteen species—comprises all the best-known British wild social bees. The classical name of the bee to which our attention is now directed is *Bombus hortorum*, but it is also known by several popular names, such as the meadow-bee, the wood humble-bee, the hummel-bee, the dumble-bee, and the humble-bee. The word bumble, often seen in print, and more frequently heard spoken, is entirely incorrect. The old English word humble, to hum, recalls the German *hummel*, a humble-bee, and *hummen*, to hum. Thus humble-bee is but an older English equivalent of the name humming-bee.

Although often seen in town gardens, it is a rural insect, very seldom found building within the area of bricks and mortar; but its vespiary may occasionally be found in large gardens and plantations surrounded by houses. It is a powerful and at times a swift flier. It

goes a long way from home, and this largely accounts for its casual visits to flowers in town gardens. The writer once endeavoured to colonize a queen of this species in a small back garden; but although she settled down in the hole and began to build, the place was forsaken.

The position in which the humble-bee prefers to build her vespiary is a grassy bank in a field or quiet lane, where there is a hole made by a field-vole or a grass snake, with a gallery running in the bank for twelve or eighteen inches, and large enough for two bees to pass. In the summer the large female bee can be seen searching banks for these conditions. If such cannot be found, she will dig a suitable gallery.

At the end of the previous autumn she had left the old home and sought a convenient hole in such places as a hollow tree, old ruin, haystack, thatch of cottage or barn, or hole underground, in which to pass the winter and spring in hibernation. These hibernating females are often tempted to leave their retreats on sunny days in mid-winter. Records have been made of specimens on the wing

during the months of December and January. But the hot sunshine of summer arouses them to full activity.

The bee's method of selecting a building site is somewhat fussy to human ideas. She is first here, then there, in and out of any little hole, away and back again, cheerfully humming all the while, and taking a long while to make her selection. When the presence of a spectator is discovered, the hum changes to an angry tone, and the spot is forsaken, temporarily, at least.

A suitable hole having been found, the bee proceeds to enlarge a part of it at some distance from the entrance. This is accomplished with her mandibles by biting away portions of the earth and carrying them outside. The maternal instinct rapidly manifests itself, and she quickly gathers materials for the vespiary.

The earliest conditions of home preparations are very similar to those of a queen wasp. The queen unaided excavates the earth for the cavity, procures the material for the covering, the wax for the cells, and builds them, afterwards laying the ova and

feeding the larvæ when they hatch, until the workers emerge and perform these duties. But she does not, however, like her hive cousin, *Apis mellifica*, or even the royal Vespidæ, spend the remainder of her life as a prisoner within the vespiary, incessantly producing ova, but enjoys the same freedom of outdoor life as others of her family.

The vespiary has no resemblance whatever to a vespiary of a wasp. (For a description of the latter see p. 129.) The materials employed by the humble-bee are short pieces of fine grass, pieces of leaves and their petioles, root fibres, small feathers, and a little moss, all moderately firmly woven together. The covering will hold together fairly well, but not much force is necessary to shake it to pieces. It forms a dome or covering over the cells, and protects them from contact with the earth above and around them. It is soft to the touch. Great care must be exercised in digging the earth away, and during the removal of the vespiary. Sometimes pieces of rags and paper are incorporated with the herbaceous substances. The base of the structure is a layer of the same materials

about an inch thick, but in very small fragments, and some admixture of loose earth.

The vespiary shown in the illustration is of average size, composed of materials just enumerated, but without rags or paper. It was dug out by the writer from a bank in a field near St. Leonards-on-Sea. The gallery leading to it was 14 inches long. There are sixty cells. At the time it was taken very few of the inhabitants were at home. The entire structure would rather more than fill an ordinary breakfast cup. The 50-mm. scale will enable the reader to appreciate the size. For the purpose of photographing it has been arranged as nearly as possible in its original condition, except that a portion of the dome is removed to expose the cells; in nature they are entirely concealed. A few of the bees have been artificially placed, whereas they would be within the dome. The large bee on the summit of the dome is the queen and foundress of the little community; all the others are workers.

There is little danger of being stung while taking a vespiary of this species; it may be more easily studied, and with greater

immunity from being stung than either the carder bee (an allied wild species), the hive bee, or even wasps, as it does not appear to be so easily disturbed or interrupted in its work, nor does it resent the presence of an observer, as do these other kinds.

The population of a vespiary of the British Bombi is never so numerous as that of the hive bee or of the social wasps. The usual number at about the end of the summer is from 125 to 175; some vespiaries, however, contain as many as 250 individuals.

The cells made by this bee are very irregular in size, varying from 7 mm. to 15 mm. in their long axis. The shape is ovoid, not at all like that made by *Apis mellifica,* which is hexagonal. They have no covering between them and the dome, except occasionally patches of coarse wax. They are affixed to each other without any definite order. Some cells are occupied with larvæ, other cells are filled with honey. The queen first builds a cell of wax until it is very much in shape like an inverted thimble, although considerably smaller; she then fills it with pollen and honey, deposits several ova in it,

and finally closes it with wax. According to Kirby and Spence (*Intro. Entomo.*), the workers endeavour to seize the ova from her, and will even remove some of them from the cell and devour them. This is presumed to be considered by the workers as a necessity, to keep the population of the colony in due bounds. For six or eight hours the queen has to guard the cell, else the workers would tear it open to secure the ova.

The queen works very rapidly. It is stated that only half an hour is necessary for her to construct a cell, fill it with pollen, deposit the ova in it, and close it.

The larvæ are large, fat, white, round-bodied creatures, with little horny heads, and their bodies always slightly curved. When they have completed their feeding, each spins for itself an oval cocoon of coarse silk, rather irregular in shape, very soft, tough, and thick in consistency. When they have attained their perfect shape, they gnaw a round piece from one end of the cocoon, and emerge. They do not, however, leave the vespiary for several days; the thick hair with which they are coated is matted together, and neither

their wings nor their legs are sufficiently strong to carry them far.

The inhabitants of a mature vespiary of the humble-bee may be classed under four headings. (1) The foundress, and other females as large as herself, most of whom will be foundresses of new colonies the following year. These latter emerge from the pupal state late in the season, pair with the males, and go into hibernation for the winter months. (2) Males or drones, which are somewhat smaller in size. They emerge from the pupal condition at the same time as those just mentioned. Next to them are (3) the workers, which are not so large as the males; but they are the most numerous section of the community. To them is committed the general work of the vespiary, attending the queen, the larvæ and the pupæ, and building the waxen cells to contain the honey; they also forage for wax, nectar, and vespiarial material. The smallest of all are (4) the small females, or minor queens, which are only about one-fourth the size of the queen. They produce ova from which only small bees develop. Several may be seen in the illustration.

The male bees do no work in the vespiary. They roam away from it to visit flowers and obtain their own sustenance, but they are unfitted to collect nectar or wax, or to form the cells or attend the larvæ. They are inoffensive and harmless, having no sting; but they can and will, if held by the wings, nip with their mandibles any small object presented to them. Towards the autumn they are very commonly seen amongst blossoms, and from the fact of their inability to stab their captor the erroneous idea has arisen that all humble-bees are harmless. The Bombi generally are not pugnacious, but, like similar aculeate insects, they attack man and beast to revenge injury which they have received or apprehend.

There is very great variation in coloration of the same species of the Bombi, and experts are sometimes unable to decide from this feature alone the various species with absolute certainty.

The popular idea that a bee can suck honey out of a blossom is not correct. No bee has a tubular tongue. The tongue is composed of three long, narrow, flat pieces

covered with hairs, and used in the manner of a brush to lick or scrape the nectar from the receptacle in the flower, which is then swallowed and passed into the crop, where it undergoes a change in consistence, flavour, and perfume, afterwards being disgorged in the form of true honey.

As the tongue of a Bombus is rather short, there are many flowers whose nectary it cannot reach in the ordinary way; the construction also of some blossoms debars them from entering. The bee then resorts to the plan of biting a hole from the outside, and it will puncture the base even through calyx and corolla. The blossoms of the broad bean are constantly attacked in this way, and a bee will begin at the end of a row of beans and visit every blossom in order.

The blossoms of the foxglove are peculiarly adapted for the visits of the Bombi, and they go to them in a most thorough and systematic manner, beginning at the lowest bell, disappearing completely within it, shortly to emerge and enter the bell next above until every open blossom on the spire has received attention; another spire is then ascended,

the pollen being carried from blossom to blossom.

The Bombi are extremely useful in the fertilization of many kinds of flowers, the specially branched hairs upon the body being the means of entangling the pollen. A few of these hairs are shown in the photomicrograph in the right-hand upper corner of the illustration.

The great life-mission of these bees is to house and rear their progeny, and while collecting food for their larvæ and themselves they transfer the fertilizing element from blossom to blossom, thereby producing edible seeds for man, beast, and bird.

XVIII

THE MASKED CRAB

THE diversity in the appearance of some creatures during the very earliest stages of their life, and when they are adult, is very remarkable. Among the lower orders of Nature this phenomenon is most clearly exemplified in the early periods of the life history of the crabs. Crabs, together with shrimps, crayfish, lobsters, centipedes, and similar creatures, are included in the order of nature known as Crustacea. The word 'crustacea' indicates that the animal so designated has a hard surface to its body. This outside skeleton is popularly spoken of as a shell. That, however, is not a correct term, because it is very different from the coverings of the whelk, mussel, snail, and others. The skeleton, too, is more correctly described as an exo-skeleton; but, from fear

PLATE No. 18.

THE MASKED CRAB

MALE (1) AND FEMALE (2) OF MASKED CRAB.

Corystes cassivelaunus, Pennant.

Also diagrammatic representation (3) of three stages in the infancy of Crabs (enlarged).

Two-thirds nat. size.

of ambiguity, the popular words will be used in these notes.

Few marine creatures afford so much amusement to juvenile and adult visitors to the rocks and sands as the crabs. Their queer, irregular gait; their menacing attitude, as with claws lifted high they threaten vengeance, all the while they are hastening to some retreat of safety, and their curious habits and appearance, cause them to be regarded with much interest; while to be pinched by one of the large claws is an experience productive of a sudden exclamation, and a prolonged remembrance of discomfort or pain.

The crabs depicted in the illustration are not so often seen on the beach and sands as the common or shore crab. It is a species frequenting deeper water than does the shore crab, but after storms or gales they are cast upon the beach, where they quickly die.

This crab presents several features of peculiar interest. One feature is unique amongst the Crustacea, viz. the marks upon the shell. The classical name given to it by Pennant, who discovered it, is *Corystes*

Cassivelaunus. Thomas Bell, however, bestowed upon it the appellation of 'masked,' 'because of the remarkable similitude to the features of the human face,'[1] portrayed by depressions and elevations on the shell. By this name it is known on every shore of the British Isles. The marks are easily recognized in both sexes, more distinct on some specimens than others, but usually more so on the shell of the male than on that of his partner, who is always the smaller creature of the two. Another prominent feature is the abnormal length of the front pair of limbs of the male; the pincer-like claws, or chelate limbs.

Like many other peculiarities in Natural Science, it is difficult to decide what definite purpose or purposes these serve. It may be that they facilitate the capture of food, since the habit of the crab is to bury itself in the sand, with its antennæ alone projecting. The female, however, is destitute of long limbs. As their habits are obscure, and the opportunities for studying them in their native state are very rare, it must continue to be a matter of conjecture as to why one

[1] T. Bell, *British Stalk-eyed Crustacea*, p. 169.

sex should be so widely different from the other.

The name of this crab is peculiar, and its signification somewhat obscure. The first, or generic, *Corystes*, means an 'armed warrior.' The mention of Cassivelaunus leads the mind to the days of the Roman invasion of Britain, because one of the British chiefs was a determined opponent of Cæsar. Whether Cassivelaunus was possessed of abnormally long arms or legs history does not inform us. P. H. Gosse, in *A Year at the Sea Shore*, p. 129, conjectures a different reason for the name.

In the upper portion of the left-hand part of the illustration are three small figures. They are drawings of magnified representations of early stages in the life of a crab.

The female, or hen crab, produces a very large number of ova. When extruded the ova are coated with a film of viscous substance, which becomes thin, and forms threads, attaching the ova to each other, somewhat in the form of bunches of grapes. The entire mass is carried about by the parent, entangled among the fine hairs with

which her swimmerets are fringed, until the period of hatching, when the brood disperse. The young crab on leaving the egg presents a very grotesque appearance. It has a large, somewhat globular body, with two staring eyes, several pairs of short limbs, fringed with hairlets, used for propelling itself in the water, and a long cylindrical jointed abdomen. After a while it throws off this covering, and appears as seen in profile at figure *a*. This is somewhat like its previous stage, but in addition the body now possesses two long curved spines. Both these conditions are spoken of as the zoëa stages.

When very young, the crab casts off its covering frequently, as often as its increasing size necessitates its doing so, each successive change producing some alteration in its contour.

The next stage of interest is seen at *b*, as it appears when looked at from above: a great difference from its former state is noticeable. It is now approaching in likeness to the perfect form. The elongated, six-jointed tail, or abdomen, has become broader and flatter, and is also provided with several

pairs of swimmerets, the spines have disappeared, while the legs are well developed. The eyes, instead of being embedded in the skin, are now each raised upon a stalk or peduncle—a persistent feature of crabs, lobsters, and shrimps; hence they are known as Stalk-eyed Crustacea. The fore limbs are provided with movable claws or chelæ, and from the head project a pair of feelers or antennæ. The animal has still the power of free locomotion in the water, the movements being effected by continued flexions and extensions of the abdomen, and pulsations of the legs. In this stage it resembles a lobster in appearance.

Another advance towards its final shape is seen at *c*. Here the abdomen is not visible. Its disappearance is due to the fact that it is now and henceforth curved under and pressed against the other part of the body. This is characteristic of all crabs, and consequently they are named *Brachyura*, 'short-tailed'; while lobsters and shrimps, whose tail-like abdomen remains extended, are known as *Macroura*, 'long-tailed.' The figure *c* represents the creature when it is about

5 mm. broad, and it has attained a form which closely agrees with that of the adult. After a subsequent moult it will be a perfectly-formed crab, and no alteration takes place except its increase in size. Each successive moult or change of covering allows the animal to add to its bulk, and this continues for many years.

The largest edible crab of which the writer has any record was captured during August, 1905, between the Longships and Wolf Lighthouses, on the west coast of Cornwall. It was a male, and measured 12 inches in width; the large chela limb was $10\frac{1}{4}$ inches at its greatest circumference, and the animal weighed $12\frac{1}{2}$ lbs.

The shell of a crab is in reality a skin which is more or less completely hardened by several additional substances. Analytical research has shown that there are six component parts in the shell substance. Small quantities of phosphate of magnesium, phosphate of lime, and soda and salt, together make about one-tenth of the bulk; animal matter about three-tenths; the remaining six-tenths carbonate of lime. It is not

produced in layers, in the same manner as the valves of oyster and scallop, but in a series of distinct rings or segments, each usually having articulated to it a pair of appendages. The amount of food the crab can obtain regulates the frequency with which the exoskeleton is cast off and a new one formed in its place, the new covering always being larger than the former.

The manner in which the change is effected is very wonderful. When it is about to take place the animal retreats to a sequestered spot, and there remains quiescent for a time. A new skin, which will become the foundation of the next covering, has developed throughout the whole of the interior of the animal's body and limbs. The old covering splits along the ventral surface of the sides, and through the opening the creature gradually emerges. The body portion comes off with comparative ease, but the extraction of the appendages from their cases is attended with greater difficulty, and to so great an extent that portions of the old cast] sometimes remain firmly adherent, and prove a source of hindrance

and inconvenience until after the next change.

For a time the creature is in a flaccid and defenceless condition, and hence the necessity for seclusion. But the new and soft skin surface quickly secretes the carbonate of lime and the other elements, and in due course the crab issues forth in a new costume. This casting off, or ecdysis, as it is termed, is the more remarkable because the lining of the stomach, other internal organs, portions of the gills, the horny covering of the eyes, and the abdomen with its appendages are all discarded, and in such a manner that the case in its entirety may (rarely) be picked up off the beach. The writer found one at St. Leonards in 1898.

The animal also has the power of casting its limbs. If one or more portions are torn off, the remainder of the limb is voluntarily severed from the body. The blood vessels and nerves retract, and a cicatrix forms which acts as a sheath for a new limb. In an early stage of life the member is complete at the third ecdysis after the accident,

but older specimens require a longer period. 'It is a well-authenticated fact that the roll of thunder, and the discharge of artillery over that part of the sea where lobsters resort, will cause them to throw off their chelæ.'[1]

Crabs have no organ corresponding to a tongue, but they have acute senses of smell and taste resident in the mouth parts. The two distinct eyes are composed of numbers of square facets, endowed with all the essential optical powers, and placed upon movable stalks or peduncles. The rapidity with which crabs can perceive objects coming towards them, and their resultant activity, is a sufficient indication of the visual capacity of the eyes. Crabs have also the power of hearing. The auditory apparatus consists of a cavity full of a greenish substance, covered with a membrane, over which a nerve is stretched.

If a living crab is turned on its back, and the mouth parts examined, it will be seen that a pair of long narrow plates opposite each other are continually moving,

[1] T. Bell, *British Stalk-eyed Crustacea*, p. 245.

small air bubbles issuing from between them. That is where the water supply enters, the current being maintained by those movements.

Not every crab, however, lives in the sea. Many shore crabs not only leave the water temporarily, but live at a distance from the sea. Some tropical forms spend the greater part of their lives on land, visiting the seashore only to deposit their eggs. One species, the swift-footed land crab, can actually be killed by a few hours' immersion in water.

Finally, of what use are crabs? Their food consists of carrion and refuse, and many seaside resorts would be extremely unwholesome, were it not for the labours of these useful scavengers.

PLATE No. 19.

THE COMMON ADDER.

AN ADDER. *Vipera berus,* Linn.

Basking in the sun and coiled in the decayed stump of a tree in a wood.

(One-eighth nat size)

XIX

THE COMMON ADDER, OR VIPER

THERE are very few creatures so thoroughly disliked, and, indeed, feared also, as a snake. The sinuous gliding movements of the creature, the scaly skin, the cold and clammy feeling to the touch, and the menacing, albeit harmless forked tongue, are individually, or unitedly, sufficient to cause instinctive repulsion in the mind of those persons unwillingly brought into contact with a snake. But there are harmless as well as harmful snakes, and also creatures like them (the slow-worm—a footless lizard, for example), which are not only innoxious, but are not snakes at all.

During warm days in the latter part of the month of April, snakes may frequently be seen in rural districts sunning themselves on sandy banks, among rough stones, on the

top of an ant-hill, or in a decayed tree stump, as seen in the illustration, and preparing for life's activity; the warmth having aroused them from the winter hibernation.

Snakes have no external limbs, nor does the skeleton show any trace of anterior limbs, but in some (not British) snakes there are portions of a pair of hind limbs. The skin is scaly, the scales or laminæ varying greatly in size and shape. Their mode of arrangement is two-fold; one is where they are placed in the same manner as the slates on the roof of a house, the other is where they only touch by their edges, a disposition seen upon the head and on the belly or ventral surface: when placed thus they are termed shields.

A snake's skeleton is a beautiful natural history object. It consists only of skull, vertebræ, and ribs. The vertebræ are very numerous; each one is a superb piece of anatomy. There are about one hundred and forty-five between the skull and the caudal portion, each vertebra having a pair of ribs articulated to it; the caudal vertebræ number about thirty-five, and have no attachments.

The skull is composed of upwards of twenty sections. Therefore, in the long, slim, cylindrical body of an adult adder there are nearly five hundred little bones.

The ribs are hollow, and end in cartilage, which is connected by tissues to the broad shields on the ventral surface of the creature. When a snake moves along, it does so by the points of the ribs moving forward carrying the ventral shields with them, the posterior margins of which offer resistance to the surface upon which the creature is moving, and push the body onwards.

Snakes are remarkable for three characteristics—marvellous mobility, absence of limbs, and the extent to which the mouth and throat can be stretched.

Their movements differ from those of all other animals. The mobility is due to the special formation of the vertebræ: the nearest resemblance to a limb is the tail, which, however, emerges so imperceptibly from the body as to be entirely overlooked by the general observer. The conformation of the jaws and throat is such that objects enormously greater than the passage through which they

have to pass do finally enter the digestive system without being disintegrated. Snakes are well provided with internal organs: brain, heart, lung, liver, kidneys, etc., but are destitute of a urinary system. The blood is cold, the circulation slow, and respiration also very feeble.

There are about eighteen hundred known species of snakes, three only of which are found in England, Scotland, and Wales. These three species are the adder or viper (*Vipera berus*), the ring or grass snake (*Tropidonotus natrix*), and the smooth snake (*Coronella austriaca*). To these there should perhaps be added the small red viper, a snake very like the adder, and continually regarded as the common viper; but it is always of a red colour, more ferocious, and smaller than the adder. Upon the investigations of Dr. G. R. Leighton, the English authority on snakes, it is shown to be distinctly worthy of specific rank as *Vipera rubra*. Each of the four kinds have been found in the Hastings district.

Happily, two of the British snakes are harmless, and the adder is so timid a creature

that it will glide away at the approach of footsteps, and only defend itself if intentionally provoked or accidentally trodden upon; it then, of course, manifests its dangerous qualities.

Nobody need mistake either the grass snake or the smooth snake for an adder: its markings are so distinctive. The usual colour of the grass snake is greenish, with some dark blotches on the sides of the body and two yellow patches upon the head. The smooth snake is subject to considerable colour variation, but it is generally reddish-brown, and marked with dark spots along the back. It is very rare, and possibly not one person in every five hundred who have seen either of the other species alive have seen coronella in its native haunt. But the adder may be distinguished immediately because of the well-defined markings. At the back of the head is an A-shaped mark, the apex of which points forward; from the broad part of the mark there continues along the back to the extremity of the tail a zigzag band bordered with small blotches. All these marks are dark brown or black, variable in detail and

intensity of colour, but never entirely absent. Adders have been found with body colours ranging from dark brown to light grey, the variations being mainly due to such causes as food, climate, age, etc.

The usual length of an adult adder is about twenty inches, of which three inches form the tail. The male is invariably an inch longer than the female.

Adders hibernate through the winter to avoid the cold, retreating in September or October into holes in old trees, crevices in rocks, or hollows underground; mostly they congregate in numbers, entwined masses of them occasionally being found in such places. During this period the pulsation of the heart, respiration of the lung, and the secretive organs, almost cease. In April or May, according to the warmth of the weather, the adders reappear, and commence their summer activity.

As the adder grows, it gets rid of its tightened skin by moulting, a new skin having previously formed beneath. This change is known as sloughing. The physiological causes producing the change need not be

inquired into here, but a brief reference to the manner in which it is accomplished must be given.

When a moult is about to take place the skin at the head splits and folds backwards, the newly-clothed head is pushed through the opening, and little by little the remainder of the body follows. In order to facilitate its extrication from the old skin, the creature will crawl between stones, through coarse grass or rushes, or amongst the low twigs of a thick bush; by these means the slough is removed, usually in a fragmentary condition, but sometimes almost or completely whole and inside out, according to the surroundings against which the creature rubs itself. Under normal conditions the change does not occupy many minutes, but the time for its accomplishment varies as to whether the creature is, or is not, in good health. There is no period of quiescence afterwards, the creature is fully active and alert.

The slough is very brittle and fragile, and requires care in handling; its most interesting portion is the concavo-convex transparent scale which formed the covering of the eye.

The covering is the eyelid, an immovable membrane protecting the organs of vision, and renewed at each sloughing. An adder therefore cannot wink its eyes. The first sloughing takes place in the adder before its birth, and then about six or seven times during the following summer.

Adders bring forth their young fully formed during the months of July and August. The average number of young is about thirteen. They are from seven to eight inches long when born, perfectly marked, and ready to attack any article of food. It may be remarked that the ring snake lays eggs, and takes no further trouble about her progeny, whereas the adder is very solicitous for her family.

The food of adders consists of field-voles, lizards, including the slow-worm, the smooth newt, birds and their eggs, insects, ant pupæ, moles, water-voles, and young rats. A very comprehensive bill of fare! The method of securing prey is by pursuit, or capture as it passes by. The writer has watched a ring snake pursue a frog that was leaping ahead of it, for many yards across a field, and

ultimately the frog got away. The customary attitude of rest is, as depicted in the illustration, in two or three coils, with the head pointing outwards. It is from such a position the adder darts upon its prey with extreme rapidity. Some writers say it is repeated a second time. The muscular force used is so great that sometimes the creature is lifted from the ground.

The long, slender, forked tongue, vibrating continuously during life, is quite a harmless organ, but of considerable tactile sensibility. It can be withdrawn into a sheath, or thrust out, although the mouth be closed, through a notch at the extremity of the snout. The sense of taste appears to be but feebly developed.

The deadly power of the adder lies in its poisonous erectile fangs. They are attached to the upper jaw, and when at rest lie against the roof of the mouth enveloped in folds of membrane. There are usually six pairs of fangs in various stages of development, the foremost pair are each connected by a tube, or duct, at their upper end to their respective poison glands, which are situated near the eyes. The poisonous fluid is of a greenish

colour, and is secreted in the customary manner of body fluids. The fangs are excessively sharp-pointed, and so perfect in their finish that the tip of the finest needle is blunt in comparison. The extreme tip of the fang is solid, but the remainder is hollow, forming a canal, which is connected above to the poison gland by the duct, while below it opens externally in the front of the fang just above the point. When the adder strikes, the lower jaw opens, and in so doing brings into automatic action muscles which not only push the fangs into position, but compress the poison glands, causing part of their contents instantly to travel along the duct, through the canal, and out with much force from the aperture in the fang.

Having transfixed its prey, the process of swallowing is effected by the jaws being alternately pushed further and further over the object, the teeth in the lower jaw in conjunction with the fangs preventing its getting away; at the same time the sections of the jaws become separated, and the skin of the head and throat stretches to accommodate the passage of the food.

Another feature of interest in this connection is, that as the process of swallowing may last for some time, breathing would be impeded but for some special arrangement. While, therefore, the food is passing towards the stomach, the glottis or extremity of the windpipe can be protruded beyond the mouth, and respiration continued. The skull and jaws of a snake should be examined, if the student desires to correctly understand the facility with which the parts extend when swallowing food; the construction and arrangements are unique.

XX

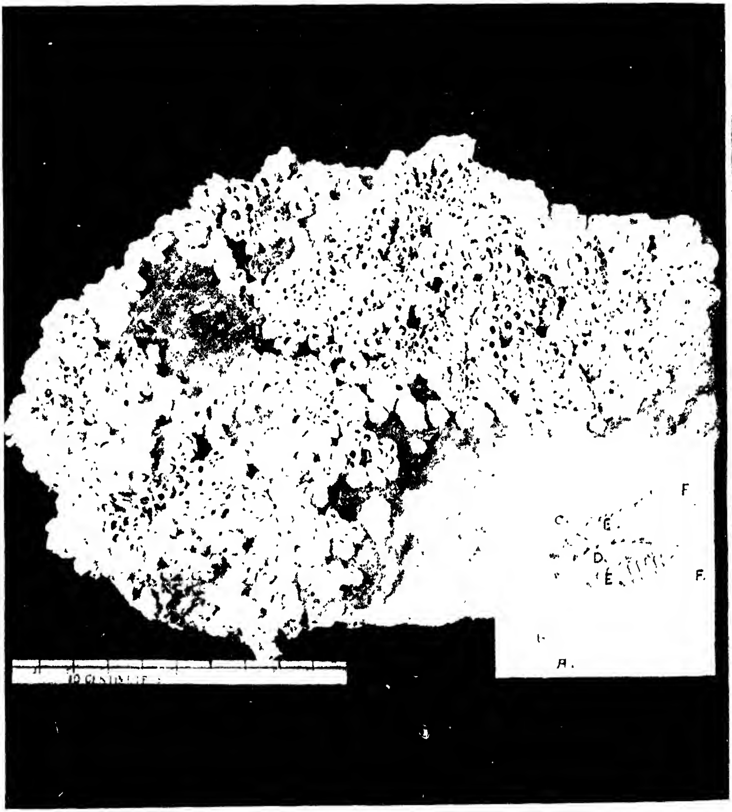
THE ACORN BARNACLE

THE pleasure of a ramble over the rocks of the seashore is sometimes greatly marred by a fall resulting from an insecure foothold on a slippery surface, or tripping in some seaweed-covered hole. In spreading out one's hands to break the fall they are often much hurt or cut by the sharp points of numberless small whitish objects scattered here and there, or in thickly covering patches, upon the rocks.

Each of these sharp-pointed objects is the calcareous case, or shell, of a small creature whose name is the acorn barnacle. Another popular name is the keyhole barnacle, on account of the hole or orifice in the summit or the shell. Its scientific name is *Balanus balanoides.* It is one of several species of barnacles that infest the rocks around the

PLATE No. 20

THE ACORN BARNACLE.



A PIECE OF ROCK ENCRUSTED WITH ACORN BARNACLES. *Balanus balanoides*, Darwin.

Also a diagrammatic figure of two cirri magnified. (After Darwin.)

Barnacles half nat. size. Diagram, × 20.

British Isles. It is of all kinds the most prolific. Sometimes rock areas of considerable extent, and also large boulders, are incrusted with the shells.

The illustration represents a slab of sandstone almost covered with them, from the rocks midway between St. Leonards and Bexhill, where they are very numerous on stones, mussel and limpet valves.

Barnacles are of two distinct kinds. One kind is that in which the shell-enclosed body is at the end of a membraneous tube; some are short, others very long, and they usually congregate in enormous numbers on floating derelict logs of wood, and on the hulls of vessels below the water-line. That kind is known as stalked, or pedunculated barnacles. The other kind has no stalk. The shelly portion is spread out in a firmly attached base upon a variety of marine objects, preferably those which are stationary. This kind is known as sessile barnacles.

The particular barnacle to which these notes refer is a species of large genus named Balanidæ, all of which are sessile, and of world-wide distribution. Some of the species

in tropical waters attain a considerable size. This genus forms part of a large order, to which the name of Cirripedia has been given; the Latin words, *cirrus*, a tendril, and *pes*, the foot, indicating the slender, jointed, curling, tendril-like limbs.

Until about the year 1820 barnacles were regarded as molluscs (snails, whelks, etc.), and classed amongst such animals; but it was then shown by J. V. Thompson that the early stages of their life closely resembled those of Crustacea (crabs, lobsters, etc.), and were quite unlike those of Mollusca. In the years 1851 and 1854 the Ray Society published monographs by Charles Darwin, dealing with all the known species of sessile and pedunculated cirripedes, which sufficed to show that their affinities are distinctly those of crustacean character, and that they should be classed in that order.

As the word 'sessile' indicates, the members of that division (which is the larger of the two) have no intermediate form of connection between the shell-enclosed body and that to which they attach themselves. They are closely seated upon the object, and are also

permanently fixed. This fixed condition has some comparison with that of limpets and chitons; but while those creatures can move from place to place on the rock surface, the cirripedes cannot do so.

The study of cirripedes is surrounded with many difficulties. Characteristic features of one species merge into those of another species so completely, that a very careful examination of external and internal structure of the shell is often necessary before its rank can be determined. The size and shape of the shell of a species is most variable. The size fluctuates very greatly. The shape depends on the position and grouping, whether they be scattered or crowded, and the surface of attachment. As there is no method of distinguishing a half-grown from a full-grown shell, the examination of a considerable number of specimens is necessary to determine the average size of a mature growth. Specimens of a normally strongly-ribbed species will closely resemble a nearly smooth species, and *vice versâ*. The area of the orifice in the same species also varies as to whether the shell is conical or cylindrical. There are

also other features of variability. A few species are not extremely difficult to determine, and happily *Balanus balanoides* is among those few.

The keyhole barnacle is extraordinarily abundant, often covering several square feet of the surface of rocks and many square yards of groynes and harbour sides. Wooden and iron pier piles and landing stages become so thickly encrusted that they are entirely concealed in every part below high-water mark. Growth, too, is so vigorous that old and long-established shells attain a height of 30 mm.

This species occurs on all shores of the British Isles in what is known as the littoral zone only, and is seldom found on objects in greater depth than that beyond low-tide mark. It is very tenacious of life, and being uncovered during the ebb and flow of the sea does not cause them any inconvenience. Specimens situated midway in the zone are uncovered for at least five hours at a time. It has also been demonstrated that although kept out of water for seven days, they will revive when replaced, but that brackish or fresh water will kill them at once.

All cirripedes increase the size of the shell by adding to the interior, but they do not, like ordinary crustaceans, throw off the old parts. If such took place, the barnacle would be exposed to the violence of the waves and attacks of enemies during the hardening of the new growth. The definite mode of growth does not appear to be understood. Darwin was of opinion that the separate parts of the shell are held together by tissue which permeates the sutures and produces growth by its continued calcification. If the shell of some species is boiled in caustic potash, the various portions fall apart, because the tissue uniting them is thereby dissolved.

The compound shell is made up of several (usually nine) portions. The centre part of each side portion is known as the parietes. The typical shape is that of an isosceles triangle, the shortest line forming the base. From each of the other lines there projects a wing-like growth named the radius. Its structure is the same as that of the parietes. It overlaps or is overlapped by a contiguous radius. From the upper part of the radius there extends a smaller but similarly shaped

piece of the same material, named the ala. The radii and the alæ fill the intervening spaces between the apices of the parietes, and form the margin of the orifice. In *B. balanoides*, and some other species, the parietal base and the radii are permeated by pores; in others they are solid. The alæ are always solid. The whole structure is firmly and securely held to its supporting substance by a membrane. The apices of the parietes are very sharp, and project beyond the level of the orifice. It is these points, causing the jagged margin of the orifice, which lacerate the hand rubbed across them.

The parietes with radii and alæ unitedly are named a compartment, and a compartment is one of the nine portions. There are usually five compartments.

Within the orifice, yet below the level of its surface, are the closing valves or the operculum. This consists of four plates triangular in outline, arranged in pairs; one pair named the scutal, the other the tergal. These opercular valves are united to the inner surface of the compartments and to each other by membrane, and thus retained

in position. They separate to allow the cirri to emerge and expand, or close to prevent any object passing into the body cavity.

The normal shape of the shell is a truncated, depressed cone, more or less cylindrical when specimens are crowded together. The colour is white, generally tinted with a yellowish or brownish epidermis, often covered with green filamentous alga. Sometimes they are a pink hue, but that is more usual in old than in young specimens. The very young are quite white. The shell is generally very strong, although some are more easily broken than others. The average diameter of the base is 15 mm., that of the orifice 5 mm., and the height 7 mm. It is very small in comparison with some of the same genus from tropical shores, the largest of which is 230 mm. high, and 65 mm. at greatest diameter. Many years ago it was discovered that the rate of growth is about 8 mm. during the three months of July, August, and September.

When the shell is taken from the water the animal closes the opercular valves, but when covered with water a number of small,

translucent, sickle-shaped filaments, known as cirri, are pushed out. These are common to all cirripedes, and hence the name of these animals. Two cirri, much magnified, are shown in the lower right-hand corner of the illustration. They are drawings after Darwin. Each creature has six pairs. They arise from the thorax, and are modified feet. They are neither natatory, ambulatory, nor branchial, but are for capturing prey, sweeping the water in the manner of a net, the cilia forming a meshwork through which the smallest creatures are not able to escape. The cirri can lengthen and shorten themselves. Each cirrus consists of a basal pedicle of two segments, the lower, A, being the larger. From the upper segment B there arise two curved, many-sided, fleshy, cylindrical cirri, CD, which taper to a point. Each segment bears two small arms or rami, EE, and at the termination of each ramus there is a cluster of bristles or cilia, FF. As the cirri are shown in profile, the rami of one side only are drawn. Reference to the illustration will assist the reader to understand why these organs are scientifically known as

multiarticulated, biramous footstalks. The higher powers of the microscope reveal the astonishing fact that many of the cilia have a double comb-like edge.

An excellent way in which these animals may be observed in a living state is to remove a limpet-shell with a number of the balani upon it, from the stone groyne or rock, and put it in a small shallow vessel with just enough sea water to cover the object. The cirri can then be seen thrust out and withdrawn with rapid, jerky movements. They can move in various directions, but mostly are curled and uncurled, controlled by flexor or extensor muscles. The action is beautifully rhythmic, and perfectly adapted to catch any object in the water and bring it to the mouth. The mouth is furnished with mandibles, toothed or serrated, with very sharp points. The alimentary canal consists of œsophagus, stomach, and a very short intestine. There are two eyes of a very rudimentary character, and also two small sacs, considered to be organs for hearing. It is difficult to understand in what particulars these senses can be of service to the animal.

The circulatory system of a cirripede is very simple. There is no heart or true blood vessels; the fluid simply moves about impelled by the muscular contraction of various parts known as lacunal channels.

The nervous system, however, is somewhat elaborate and complicated. A large number of pairs of nerves are given off from several important centres or ganglia, the largest of which is that from whence eleven pairs emanate to the cirri.

The breathing of a cirripede is performed by two organs which may be regarded almost as lungs, but branchial, and not bronchial. Each of the branchiæ is an inward fold of the membranous covering of the body, formed into ridges, plicated and sub-plicated, the centre surface being exposed to the action of the water. The water is drawn in and expelled by the constant movement of the opercular valves, while other muscles cause the folds to open and close, so as to keep the water continually circulating between them.

Like a large number of lowly marine creatures, cirripedes begin life with a free

existence. The embryonic creature which is known as the larva hatches from the egg, and remains within the parent, undergoing several changes before issuing forth. Upon emergence it is ovoid in shape, sufficiently transparent for the internal organs to be located, and provided with three pairs of swimming legs, which have forked terminations, a pair of antennæ, one eye, and other organs. During the roving condition it moults several times, altering its shape and appearance, and becomes a pupa. In the last moult the antennæ are subject to great changes, the most important being that the extremities are formed into discs, causing them to adhere, and moor the animal to rock or wood, to which it then remains affixed. The larval covering is thrown off, and the shell becomes the permanent structure. Other glands secrete a fluid which, flowing through tubes, forms the membrane by which the shell is held to a supporting substance. There is then no further change. The animal cannot leave the spot.

Although the effect of a number of balani in a living condition is very fine, they are not

suitable inhabitants for a marine aquarium; they soon die, and cause the death of other creatures around them. They require incessant agitation of the water, and to be left alternately dry and immersed in a manner similar to that to which they are accustomed in their native state.

PLATE No. 21.

BLOSSOMS AND FRUIT OF THE BLACKTHORN.

Prunus communis, Hudson.

Left-hand side of illustration, Blossoms and Leaves of Wild Bullace.

(*Blossoms, nearly nat. size. Sloes, half nat. size.*)

XXI

THE BLACKTHORN, OR SLOE

THE rapidity with which trees unfold their foliage during the months of April and May is most wonderful. The majority of plants have well-developed leaves some time before the blossoms appear, but there are a great many trees whose blossoms have opened, and the petals fallen, ere the leaves have expanded. Of large trees the elm and the poplar are well-known examples. The massed bunches of small florets of elm, and the reddish, hirsute, pendulous catkins of the poplar, are familiar sights in the parks and gardens and along many roads. Of smaller trees in town gardens in the spring-time there are many almond trees in full bloom, as well as other fruit trees in all their wealth of glory.

While walking along the country lanes, or rambling around meadows and by the brook-side, one cannot fail to notice several kinds of trees and bushes ablaze with white blossoms, but with few or no leaves: blossoms in such profusion that long stretches of the twigs they are growing upon are obscured from view, and crowded so closely together that it appears to be a struggle for existence, yet every blossom that can do so throws open its petals to the widest, thrusts out its filamentous stamens and pistil, and proclaims as loudly as possible its desire for the visitation of insects.

The common wild cherry is such a tree. Its tall, slender, and graceful branches towering above the humbler components of the hedge or copse look as though numerous bunches of snowflakes on stalks had been tied upon them, and from among the bunches there peep here and there a few tender greenish-yellow leaves. Two other bushes found in the same kind of situations, by their profusion of blossoms loudly proclaim their presence; one more vehemently than the other, it is true. That one is the

blackthorn, or sloe; the other, a very near relative, the wild bullace. Both are represented in the illustration.

The blossoms and leaves in the upper half of the left-hand side of the illustration are of the bullace; the other clusters of blossoms are of the sloe. The reader's attention is directed to two features: the blossoms of the bullace are larger but less numerous than those of the sloe. Both species belong to the Rosaceæ family of plants. It is a family that embraces the pear, apple, medlar, cherry, blackberry, raspberry, strawberry, and others, the roses, of course, included.

The sloe is known in botanical nomenclature as *Prunus communis*. Both words are from the Latin. *Prunus*, the generic name, is the order of fruit trees to which all the plums belong: the greengage, the bullace, the damson, and kindred varieties; *communis*, signifying common, general. Pliny the Elder first gave the name of *prunus* to the plum tree. In some botanical works the sloe is named *Prunus spinosa*. The word *spinosa*—thorny—is an indication of the nature of the

small and young twigs, all of which terminate in a sharp point.

The tree may be found in hedges, thickets, and open woods abundantly throughout Britain : sometimes very short, sometimes tall, seldom more than ten feet high, and always much branched. Whether seen in the early spring, when it is in full blossom, or in the autumn, when its branches are laden with fruit, it is a noticeable feature wherever growing, and one familiar to all dwellers in rural districts. It is worthy of remark that there is often a spell of sharp weather and cutting winds while the blackthorn is flowering, and such a period is in many parts of the country known as blackthorn winter. 'Whether the wild bullace is a different kind of plant from the common sloe or blackthorn botanists are not agreed, and in some parts of the country bullaces are called sloes. The plants have, however, a different appearance, for the sloe is a shorter, much more thorny bush, and produces smaller flowers, much more crowded together before the leaves begin to show. In the wild bullace, on the other hand, the leaves appear about the same

time as the flowers, and are more downy. The fruit also is larger and less sour.'[1]

The blossoms are arranged upon the stem in clusters, eight, ten, or more, springing from one centre, and crowded together in great numbers. There are two hundred and thirty-three blossoms and buds on the two twigs in the right-hand half of the illustration, and they are not abnormally numerous. Each blossom is attached to the twig by a short stalk: nominally the calyx is five-lobed, and there are five petals, but four and six are not uncommon. Each petal is cupped, both upper and under surfaces are white and wax-like, ovoid in outline, the margins being quite smooth, and measuring about 6 mm. long and 4 mm. wide.

From the hollow centre of the calyx the yellow pistil arises, and around it are grouped, in a stellate manner, the stamens; these also are variable in number, but there are generally sixteen. They are inserted, with the petals, on the lip of the calyx. The microscope shows them to be a creamy translucent white. The anthers, at the distal end of

[1] *The Country Side*, vol. ii., p. 82.

each stamen, contain the pollen. When viewed by the same means the anthers are seen to be reniform in shape, crimson and orange in colour, having a reticulated surface. When ready to distribute their contents they split open, and the colour becomes a deep purple, the pollen itself appearing like minute ovoid granules of burnished gold. A single blossom under a low power (3 inches objective) of a microscope is a very interesting object; charming in its delicate simplicity and perfection of structure.

As soon as the flowers have been fertilized the petals fall. A sharp rap on a branch will cause a miniature snow shower, and repeated blows on the bush will quickly produce a white layer on the ground. As soon as the blossoming is over the leaves begin to appear, unfolding from long pointed cylindrical rolls; dainty objects of emerald green hue, maturing rapidly until they attain a length of about 3 cm., and attached to the twig by a petiole about 1 cm. long; lanceolar in shape, the margins being finely serrated. The upper surface does not show the veination very distinctly, but on the under surface the

mid-rib and its offshoots produce distinct ridges. When mature the colour is olive green, later becoming brown, much darker on the upper than on the under surface. In both these stages of coloration the leaves form a charming contrast to the fruit. In years gone by, when tea was very expensive, the leaves were largely used in England as an adulterant.

The fruit is a fleshy or juicy drupe, in the centre of which is a hard thick shell (or stone), smooth or rough, but not wrinkled on the surface, containing one and sometimes two seeds. Drupe is the technical word applied to a succulent fruit which envelops a stone with a kernel or seed within it. The word 'drupe' has reference to the olive of Eastern countries, which, when over-ripe, falls from the tree.

In shape the sloe is oval, about 15 mm. in its longest axis; sometimes it is almost globose. It is many weeks attaining maturity, and is seldom ripe before about the middle of August. When ripe the colour of the rind is purple, which in its pristine condition is concealed by a bloom of waxlike consistence, which the slightest touch of finger will

remove. Six specimens of the fruit are shown (half natural size) in the oval portion of the illustration, that on the extreme left having had the bloom rubbed off.

Many young people eat the fruit, but few adults care to taste them a second time. They have an excessively astringent flavour. It has been stated in print that 'cottagers sometimes pickle them in an unripe condition in salt and vinegar,' and also 'when ripe make a kind of preserve of them.'[1] Neither preparation, however, can be very pleasant nor sweet to the palate. That a spirituous liquor is made from the ripe fruit and sold as sloe gin is well known; and one has school-day memories of a very simple method of bottling them with sugar and water, and putting by for several months to mature; but they were rarely allowed to reach that desirable condition. Probably the fruit is largely eaten, and also stored for winter consumption, by squirrels, dormice, field-voles, and similar creatures, to a far greater extent than it is eaten when in a ripe state by birds, and thus it serves its part in Nature.

[1] F. E. Hulme, *Familiar Wild Flowers*, vol. ii., p. 82.

PLATE No. 22.

THE SESSILE-FRUITED OAK.

A GRAND OLD TREE OF *QUERCUS SESSILIFLORA*,
Broomham Park, Guestling, Nr. Hastings.

The tree is subject to the attacks of various diseases and fungi. Insects also prey upon it very considerably. The larvæ of three butterflies and sixty-three moths are found upon it. Of the moth larvæ three kinds also bore into the twigs. Some roll, fold, and bunch the leaves together with silk, and secure both food and shelter; another eats tunnels in them. The larva of a two-winged fly makes cymbiform pouches of them, and eats the interior. At least four species of aphides and one of the scale insects are found on them, while an exceedingly small mite makes little pouches along the margins. Various species of a fungus (*Polystigma*) causes red, fleshy blotches on the leaves.

The fruit is attacked by another parasitic fungus, widely distributed and common in Sussex, named *Exoascus pruni*, producing what are known as mock, pocket, or starved fruit. It causes the fruit to swell to about four or five times its normal size, devoid of stone or kernel, and totally unfit for food. This fungus is also found on plum trees in orchards, and as the mycelium (threadlike portions) remains from year to year in the

soft bast of the branches, its eradication is a difficult matter, even although deep pruning is resorted to. The fungus attacks the very young fruits as they begin to swell, and causes their tissue so to change that instead of a normal-sized plum with a properly-formed stone containing its seed, there develops an unequally-formed greenish-yellow, tough, abnormally large substance, which ultimately is covered with a greyish powder, and spotted and rotten with the fungus. A section shows a relatively small cavity, either quite empty or with a shrivelled remnant of what would have become the seed.

XXII

COLOSSAL AND ANTIENT TREES

VERY few objects in Nature more readily assist the imagination, when endeavouring to realize the proportions of a landscape, than a tree of ordinary size and growth. When a verbal description of a district or a country is given, it is rarely that the places and positions occupied by trees are omitted. If they are, the place must be either a barren and desolate waste, or the one who describes can have little or no appreciation of one of Nature's grandest gifts to mankind.

The earliest record of any spot on earth contains the mention of trees. Through all ages poets, artists, scholars, and worshippers have lavished their praise, their skill, their eulogy, or their reverence upon trees; and

little wonder. The beautiful tints of the foliage, with its delicate and graceful proportions; the suppleness of the young trees; the strength, massiveness, and majesty of the ancient ones; and the charming varieties,—all appeal to our sense of admiration.

In dealing with trees, first of all in regard to their height and the size of their trunks, it is perhaps only natural that our thoughts should go in the direction of that continent where most things are on a vast scale. But where else shall we look for such an assemblage of mammoth trees as are growing in the Yosemite Valley in California? There we find some of the most remarkable trees in the world. The most renowned is that known as 'the Californian Big Tree.' Through the base of its trunk a space has been cut and a roadway formed, more than large enough to allow a coach and four to pass through, yet this does not at all interfere with the growth of the tree.

This tree is 275 feet high and 84 feet in circumference, and is but one of eighty trees of similar proportions in the Mariposa Grove. Another of these specimens has a cavity

within it which can give shelter to nineteen horsemen at one time. Another is named 'The Mother of the Forest'; it is 327 feet high and 75 feet in circumference at the base, but it is dead and barkless. The finest of them all is known as 'The Father of the Forest,' whose trunk measures 110 feet in girth, and rises to a height of 300 feet, where it has been broken off; and taking the average taper of the surrounding trees into consideration, it is said that this tree may reasonably be supposed to have been upwards of 400 feet high.

It is also said that some of the eucalypti trees in Western Australia are even higher, attaining to 500 feet.

The celebrated 'Somma cypress,' in Venetian Lombardy, is 120 feet high and 23 feet in circumference at its base. Rather than destroy or cut it down, Napoleon deflected the road he constructed over the Simplon. It is said to have been a large tree forty years B.C. Thus its age is upwards of 2000 years.

Another huge cypress tree flourishes in Mexico. Its circumference is 170 feet; its

height more than 250 feet. All the year round its branches remain green.

A chestnut tree growing at Mount Ætna, in Sicily, appears to furnish the largest figures as regards bulk of trunk. Its appearance is as though five large trees are growing together, but they are in reality perpendicular branches, which rise from one solid stem, the circumference of which is 240 feet.

Another tree of vast proportions is the great pine tree of Otsu, in Japan. It is 84 feet high, and the spread of its branches is more than 240 feet in diameter.

Banyan trees also furnish figures which are truly wonderful. One growing on an island in the River Nerbudda, of Senegal, spreads, by reason of the stems formed by about 3000 adventitious roots, over an area sufficient to shelter 7000 men. The circumference of the main cluster of roots, those which are regarded as the trunk proper, is 2000 feet.

After the enumeration of such figures as these, the dimensions of trees growing in England will appear small; but it must be borne in mind that these latter examples

grow in a climate and a temperature much more suitable for the growth of every description of vegetable matter. However, there are a number of oak, yew, willow, ash, and other trees, on English soil, the enormous proportions of which are wonderful.

Near Aylesbury there is an oak tree whose height is 90 feet, and at twelve inches above the ground the trunk measures 25 feet in circumference. An ash in Woburn Park, in Bedfordshire, is the same height, but measures only 23 feet in circumference. The trunk rises for 28 feet without a branch.

Willow trees 75 feet high, and elms at 60 feet, are worth but a passing comment when compared with the altitudes just enumerated. When, however, standing alone, they are grand and majestic.

Near Bristol there is a chestnut tree, the trunk of which is nearly 50 feet in circumference, and at a height of ten feet it divides into three huge limbs, one of which is nearly 30 feet in girth.

The largest English lime tree is probably the one in Moor Park, in Hertfordshire. It

is about 100 feet high. The trunk is 24 feet in circumference at the ground, and rises for about 75 feet; it then divides into 19 branches, each of which is about 8 feet in girth.

There are many large yew trees in different parts of England, Scotland, and Ireland. The most celebrated is in the parish of Fortingall, in Perthshire. Some years ago the trunk of this tree measured, according to Pennant, 56½ feet in circumference. At Wyrardisbury, in Bucks, there is one, the trunk of which at six feet from the ground is 35 feet 5 inches in circumference.

The most magnificent beech tree in England is reputed to be the one in Knole Park, in Kent. It is 105 feet high, and at three feet from the ground the trunk is 24 feet in circumference. One of the famous Burnham beeches measures 27 feet in circumference at the ground.

Many more examples might be given of trees growing in various parts of the world, the proportions of which are amazing.

There is, however, another aspect of our subject, a second division of the title chosen

for these remarks, viz. the great age to which many trees attain.

It is astonishing to what a great age very many trees live. As years pass away the effect upon man, after he has passed the prime of life, is declining strength and diminishing faculties, and if he lives to be 100 years old he is considered a venerable old man. The ravages of time may be plainly seen in the ruins of many an ancient castle or abbey, whose foundations were laid 500 or 600 years ago; but the accumulation of years has an opposite effect upon many a tree, by increasing its bulk and height, and thickening and lengthening its roots. In the spring trees renew their youth, early in summer they clothe themselves anew in softest and most delicate shades, reserving their grandest and most gorgeous attire for the autumn, which later gives place to the sere and yellow leaf; but, meanwhile, a store of energy and power has been reserved by which they are fortified against the tempests of the winter, and which is not expended ere the following spring arrives.

And so they live from age to age, from

century to century, until thousands of years have passed.

In the year 1869 the famous colossal dragon tree of Orotava, in Teneriffe, was overturned by a storm. It was 70 feet high and 48 feet in circumference, and, according to local legend, could not have been much less than 4000 years old.

The Nerbudda banyan tree, of which we have previously given a few details, is mentioned by the historian Nearchus as being capable of sheltering 10,000 men in the time of Alexander the Great, 2250 years ago. And how many years shall be added to those figures that passed ere it had attained sufficient dimensions to shelter such a host?

The oldest living oak tree in Great Britain is near Rilcston Hall, in Yorkshire. It is a remnant of the forests of ancient Britain, and a monarch among trees. The trunk is hollow, and will contain 70 people. The age is about 1500 years.

Near it is the 'Major' oak, the trunk of which is hollow for 15 feet from the ground. Its age is upwards of 1000 years. Another oak tree, growing near Warwick, was described

in 1830 in Strutt's *Sylva Britannica*, and its age then regarded as 1000.

Ancient willow trees are less plentiful, but there is one of *Salix alba* growing in Haverholm Park, in Lincolnshire, which is supposed to be upwards of 1000 years old. It is perfectly sound in trunk and limb.

The chestnut tree near Bristol was so remarkable in size in the reign of King Stephen that mention of it is made as forming a boundary signal. That is 760 years ago; therefore its age cannot be less than 1000 years.

Various authorities state that lime trees live for 1000 or 2000 years, but none attaining these years are growing in this country.

The oldest yew tree in the British Isles is supposed to be the one at Fortingall, in Perthshire, Scotland. At one time funeral processions used to pass between the two distinct parts of its trunk, and in the early years of the last century boys used to burn fires against it, to keep up an old custom, like our Hallow E'en bonfires, and later it was much cut about by curiosity hunters, but now it is enclosed against such depredations. The

age of this tree is stated to be about 2600 years.

A yew tree in the churchyard of Crowhurst, a little village about five miles north-west of Hastings, is supposed to be more than 1300 years old.

That venerable yew tree measures 41 feet in circumference where the roots—which are compact and close to the base of the trunk—emerge from the ground; at 3 feet from the level of the ground it is 27 feet in circumference. Its height is about 45 feet. The trunk, which is very gnarled and full of knots, rises for about 8 feet, and then divides into five smaller trunks. Two of these are hollow, a third partially so, and another is quite dead and much broken. The upper portion of the fifth appears to be dead, and is upheld by stout iron bands, which pass around the soundest trunk. Another is also prevented from falling by similar bands, and were it not for these, considerable portions would fall away. Within the trunk is an irregularly shaped cavity, about 8 feet at its greatest height, and large enough to contain one adult and three children. When standing in one

part, through a small opening the upper portions of the tree can be seen. But in spite of all this decrepitude the tree is in good health.

The stoutest horizontal limb branches off on the south side of the tree. It is about 30 feet long, and is supported by a massive prop. Another limb, which is 25 feet long, grows from the opposite side of the trunk. These measurements, together with the diameter of the trunk, show that the boughs cover a space 64 feet in diameter. There are numerous evidences of small branches having been sawn and broken off. Small bunches of contorted leaves at the termination of hundreds of the lesser twigs form the well-known yew gall, which is caused by the larva of a small fly named *Cecidomyia taxi*.

Probably the question has been asked, 'Why are yew trees so frequently met with in churchyards?' Opinions as to the reasons differ widely. The belief most generally accepted is that in the early days of our nation's history the yew tree was ordered to be grown in such places to ensure its protection. There is, however, apparently no

record of its being ordered by law to be grown in churchyards. Another favourite opinion is that it was planted in such spots because it was held sacred for the purpose of making bow staves for ancient warriors. Long-bows and arrows were the chief weapons used by the English at Cressy, Poictiers, Agincourt, and other battles. Statutes were passed by Edward IV., Richard III., and Henry VIII., forbidding the exportation of yew, even though there were at that time extensive plantations of yew trees—the remnants of one is still to be seen at Kingly Bottom, four miles from Chichester—but the price of a bow stave of foreign yew in those days was 6*s.* 8*d.*, whereas one of English yew was only 2*s.*; moreover, one tree could not supply the entire parish with bow staves.

Another reason is that the tree was planted to protect the church from storms.

Scarcely any tree could be so ill adapted to protect a church, because of the horizontal direction of the branches, the needle shape of the leaves, the scantiness of the foliage, and the exceedingly slow growth (about 45 feet in height in 1300 years). The Crowhurst

(Sussex) yew tree is on the south side of the church, a point least needing shelter.

Some persons regard the massiveness and solidity of its trunk, the durability of the wood and the firmness of its grain, and also the slowly altering features of the entire tree, as emblems of death and immortality.

Others are inclined to the idea that our pagan ancestors, on their arrival in this country, finding the yew the best substitute for cypress to deck the graves of their dead, cultivated and used it for such and other sacred purposes.

Many churches probably have been built on spots where pagan worship had previously been conducted for ages, and the yew trees were allowed to remain, for it is quite possible that pagan superstition, rather than a belief in Christian principles, caused them to be planted.

Branches of these trees were used in Greece and Rome as signals to denote a house in mourning. In this country they were carried in procession on Palm Sunday instead of branches of willow.

* * * * *

Wordsworth says—

> 'Of vast circumference, and gloom profound.
> This solitary tree! A living thing
> Produced too slowly ever to decay;
> Of form and aspect too magnificent
> To be destroyed.'[1]

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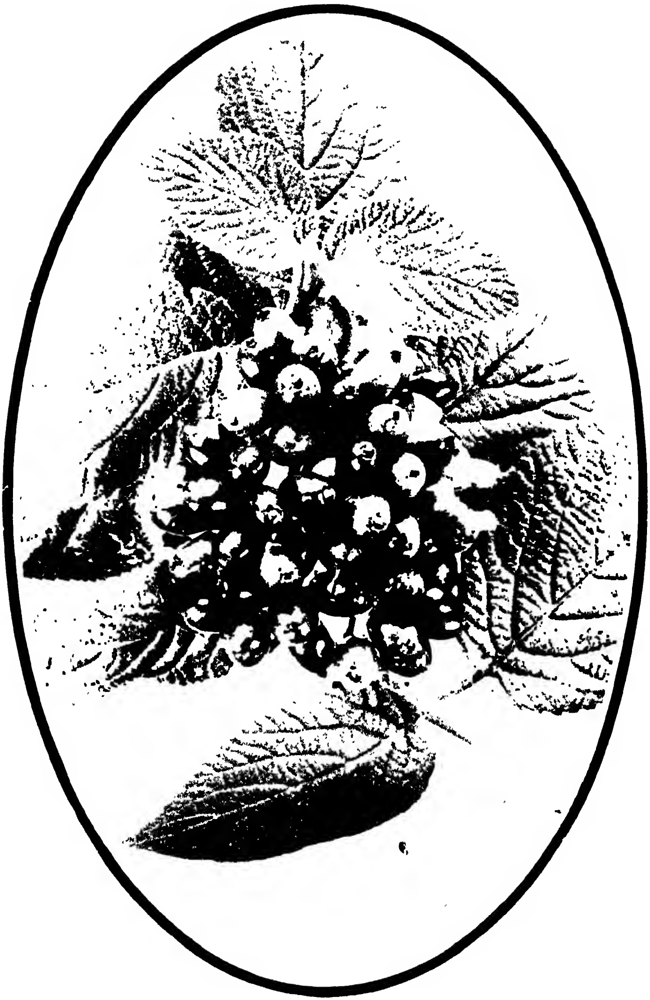
[1] *Poems of the Imagination*, V. 'Yew Trees.'

PLATE No. 23.



LEAVES AND FRUIT OF *VIBURNUM LANTANA.*

XXIII

AN ENGLISH SUNSET IN AUGUST

STUDENTS of Natural History do not, as a rule, pay much attention to the phenomena of the heavens. Objects to which they devote their investigations are such as may be found in woods, lanes, and fields, in the babbling brook and the flowing river; or in the sea, the very immensity of which, teeming with life, is in itself an inexhaustible study. But nobody whose mind has been enlightened and expanded by studying some of the many phases of Nature can fail to have his attention arrested now and again by the glorious and ever-changing appearances of the sky during a beautiful sunset.

There are several months in the year when, in England, the glories of sunrise and sunset are very beautiful, and attract a great

deal of attention. January and November are, perhaps, those during which sunsets, in particular, are very beautiful. At such seasons the clouds are very sombre in colour, and seldom absent from the sky, and the declining sun throws them out in bold relief, edging them with brilliant and vivid colours. During August, however, there are often some gorgeous sunsets a little after seven o'clock.

On one such occasion the writer was on hilly ground with a beautiful panorama stretching away to the western horizon, and from whence one of these delightful spectacles was witnessed in all its beauty. All Nature seemed to invite one to rest awhile on the green sward after a hot and tiring day, and enjoy the scenery around.

The declining sun threw the shadows of the trees far across the meadows, and lit up the distant hill-tops with glory. Not a leaf was rustling, not a sound came from the cattle browsing on the near and distant pasturages, and several windmills discernible were motionless. The rural peacefulness was undisturbed until, presently, a railway train

came round the bend of the hill, with engine panting and snorting, as if in anger at the slow pace it was enforced to observe (lest the time-tables should be disorganized), and belching clouds of dark smoke, which hung listlessly in the breathless air. When the noise of the disturber had died away in the distance, all was peaceful again.

In the southern horizon were a few fleecy clouds very slowly moving northwards, and overhead other clouds were gently passing across the azure sky. The delightful blue of the sky was restful to gaze upon, and it was interesting to watch the varying changes in the shapes and movements of the clouds. Meanwhile lower sank the sun, while gathering belts of downy cloudlets arranged themselves along the western horizon, as if preparing the softest cushion for the majestic sun to rest upon. A faint tinge of copper speedily appeared as an edging to those clouds, while others higher in the heavens were suffused with pale yellow, and the fleecy clouds, first shaded with pale saffron, gradually melted into nothingness.

To watch such movements and changes

taking place without the aid of human skill, and with such unswerving regularity of action, was deeply impressive.

The subdued twitter of the birds could now be heard as they sought a secure perch for the night in the trees and hedges near by. Now and again the bleat of a sheep or the lowing of a cow came from the distant farmsteads; the sound of children's voices was occasionally wafted to the ears, while close at hand was a wasp busily occupied in nibbling from a wooden paling some fibres with which to aid in the construction of the vespiary.

But the copper colour of the clouds was becoming more intense, the saffron was merging into golden orange, and along the edges of other clouds (fast assuming a greyish colour) purple and orange began to manifest themselves. Other fleecy clouds spreading themselves over the sky, very gradually assumed that entrancing peculiarity known as 'mackerel sky'; these also caught the declining sunbeams and were tinged with palest pink and yellow. Lower and lower sank the glowing orb, now beginning to

surround himself with a regal grandeur. Shades of grey, blue, orange, purple, and green were dispersed among the clouds near him; golden streaks swept the belt of clouds from end to end; the purple became intensified, the grey darker. The day could not suffer him to depart without a glorious and prolonged farewell. Soon his lower margin touched the clouds, the colours were intensified, and, as more and more of the disc was obscured, the edges of the clouds were changed to florid gold bordered with purple and grey. Rays of brilliant light streamed out from behind with a refulgence such as can emanate only from the sun. After a few minutes the sun reappeared from beneath those clouds like a huge disc of molten metal, and then, touching the horizon, little by little it slowly disappeared.

Far, very far, away there was pictured in the sky another glorious scene. One fancied there was a tranquil sea of gold, into which was pouring, through the numerous channels of its delta, a large river, each outlet being suffused with a golden sheen; and forming a background to this was a long bank of grey

clouds, looking like some bold and massive headland jutting into the sea. This glory was but transient. The departure of his majesty from the scene appeared to be a signal for his gorgeously-attired retinue to gather their robes about them and depart also. One by one they stole away, and the invisible scene-shifters began their duties.

The gold almost imperceptibly merged into orange, and the orange into crimson, then to purple, and that melted away into grey, and the grey became less and less intense, until the shades of evening asserted themselves, absorbing all that remained, and giving in place a grandeur peculiarly its own. The deepening hue of the sky told that the glorious sight was concluded—the last scene in one of Nature's grandest plays was finished.

It was profoundly grand to witness such vast transformations being worked out in perfect silence.

Evening zephyrs caused the leaves to move tremulously, as if they were afraid to disturb the solemn silence. The dew began to manifest itself, and it was not until the evening star shone like a point of silver set

in a vast cloudless expanse of deepest blue, that one could cease to gaze upon such glories and, turning steps homewards, meditate thereon, and in some measure comprehend why heathen in all ages have worshipped the awe-inspiring *Helios*.

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